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Vol. 32 • Issue 12

Redefining the Eyepiece

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Actual Size

5 Element Plössl Series 5000

The new Series 5000 Plössl eyepieces represent a milestone in design and engineering. The five and six element designs feature tack sharp optical performance which delivers a 40% improvement in corrections for chromatic aberration and edge-distortions over traditional plössl. They yield the widest possible fields-of-view, consistent with pinpoint edge-of-field sharpness and contrast. Compare their unparalleled 60˚ apparent field-of-view to any Plössl on the market today. Take a look through the new Meade Series 5000 Plössls and rediscover your favorite celestial objects.

- Wide 60˚ apparent field-of-view
- Premium grade optical glass
- Individually tuned, multi-layered coatings for maximum light transmission
- Lens edges and all internal metal surfaces are blackened to maximize image contrast
- Parfocal - little or no refocusing required when switching eyepieces
- Long eye relief
- Adjustable twist-up rubber eyeguards

Focal Length	Barrel Size	Apparent FOV	# of Elements	Price
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9	1.25"	60˚	5	$ 89.00
14	1.25"	60˚	5	$ 89.00
20	1.25"	60˚	5	$ 89.00
26	1.25"	60˚	5	$ 99.00
32	2.00"	60˚	5	$149.00
40	2.00"	60˚	5	$199.00

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Super Wide Angle Series 5000

The new Series 5000 Super Wide Angle eyepieces boast a 68˚ apparent field-of-view and image resolution that is razor sharp from edge-to-edge. Because of its innovative six and seven element design the objects you observe will be rich in detail and contrast with virtually no chromatic aberration. These eyepieces are made of the finest materials available, and are a perfect optical match for Schmidt-Cassegrains, fast Newtonians and Schmidt-Newtonians. First light with the new Series 5000 Super Wide Angle eyepieces will be an event you always remember.

- Super Wide 68˚ apparent field-of-view
- Premium grade optical glass
- Individually tuned, multi-layered coatings for maximum light transmission
- Lens edges and all internal metal surfaces are blackened to maximize image contrast
- Parfocal - little or no refocusing required when switching eyepieces
- Long eye relief
- Adjustable twist-up rubber eyeguards

Focal Length	Barrel Size	Apparent FOV	# of Elements	Price
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24	1.25"	68˚	6	$249.00
28	2.00"	68˚	6	$279.00
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40	2.00"	68˚	6	$399.00

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- Ultra Wide 82˚ apparent field-of-view
- Premium grade optical glass
- Individually tuned, multi-layered coatings for maximum light transmission
- Lens edges and all internal metal surfaces are blackened to maximize image contrast
- Parfocal - little or no refocusing required when switching eyepieces
- Long eye relief
- Adjustable twist-up rubber eyeguards

Focal Length	Barrel Size	Apparent FOV	# of Elements	Price
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6.7	1.25"	82˚	7	$199.00
8.8	1.25"	82˚	7	$199.00
14	1.25"	82˚	7	$199.00
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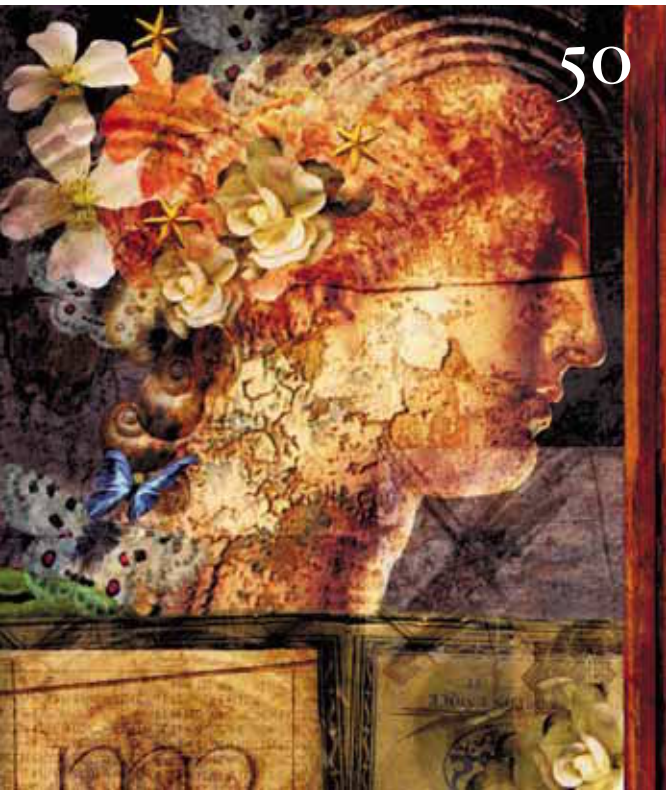

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GEORGE GREANEY

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What we can and can't do when a killer asteroid heads for Earth
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ON THE COVER

An asteroid 15 miles across hurtles toward Earth, moments before creating a devastating impact. It will send molten rock high into the atmosphere, where it will rain down onto much of the globe. Such gigantic impacts have occurred in Earth's past and will do so again. Next time, will humans be able to avert disaster? *ASTRONOMY:* ROEN KELLY

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BY DAVID J. EICHER

Are we helpless from space rocks?

Protecting the planet is a real concern

among asteroid watchers. Some 700 near-Earth asteroids larger than a kilometer are out there, and one of them may have Earth's name on it. These hefty rocks pass relatively near Earth's orbit as they follow the Sun; the cratering record on our blue planet reveals that many have struck us in the past. Just because we are now aware of it won't change that inevitable nasty bang sometime down the road. In fact, bits of asteroidal debris rain down into our atmosphere by the ton every day.

What if we discovered a big asteroid on a collision course with Earth? During the last few years, we've heard the answer as an assured, "no problem," we'll simply send a nuclear bomb to the outer solar system, detonate it, and nudge the offending rock enough such that it would no longer intersect with Earth. But what could we really do? The short answer is, nothing. We have no nuclear spacecraft nor any such devices to detonate a helpful bomb, and Bruce Willis shows no sign of loaning us one.

As astronomer Bill Cooke argues in his story, "Killer impact," on page 38, we can talk about only what might be done to minimize the damage from an asteroidal blow. Cooke, a researcher at NASA's Marshall Space Flight Center, argues the odds are a human who lives to be 100 will see a Tunguska-like impact in his or her lifetime. Tunguska, the explosion of a comet over Siberia in 1908, then, is considered a once-in-a-thousand-year event. It struck with the force of a 20-megaton bomb.

It's the larger ones with rocky or iron structure that will be really pesky. An asteroid 1 kilometer wide would strike Earth's skin with the force of 20,000 megatons of TNT. The most ominous asteroid class offers up a 10-kilometer space rock, like the one that killed the dinosaurs. Such an asteroid could easily create a global catastrophe that would end civilization. Whether it struck ground or water would make little difference; it would blast molten rock skyward, showering it around the globe, starting fires that would choke the blue planet with thick smoke and create a "nuclear winter." That scenario, which is extremely rare, will happen again eventually. And right now, we are not ready to do anything about it but watch.

IF A LARGE ASTEROID collided with Earth, the effects could be devastating. JPL

Cooke's article takes a very different approach than science writers have on this topic; I invite you to let us know what you think of his conclusions.

Yours truly,

Dave Eicher
Editor

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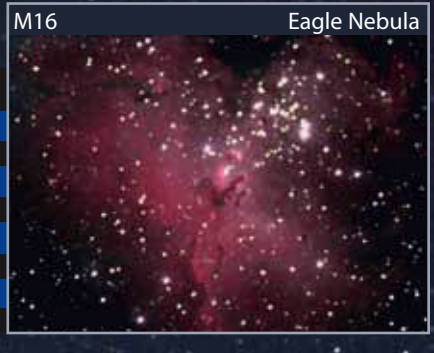
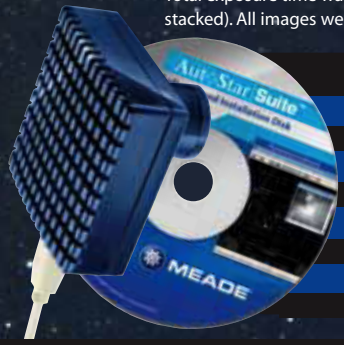
M16 Eagle Nebula





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Focal Ratio	f/5	f/5	f/5	f/4	f/4	f/4	f/10	f/9	f/9	f/8
Focal Length	762mm	762mm	762mm	812mm	812mm	1016mm	2000mm	1143mm	1143mm	1219mm
Primary Mirror	Plate Glass	Pyrex®	Pyrex®	Pyrex®	Pyrex®	Pyrex®	Pyrex®	N/A	N/A	N/A
Viewfinder	6 x 30	8 x 50	8 x 50	8 x 50	8 x 50	8 x 50	8 x 50	8 x 50	8 x 50	8 x 50
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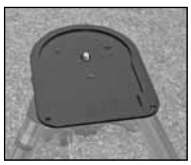

The standard locator plate greatly speeds up and simplifies the mounting of all LX200 telescopes when used in altazimuth mode on a standard field tripod. The locator plate fits to the top of the tripod (and can be left in place) and provides a precise key for the base of the LX200 to slot into. Deluxe model with eyepiece tray also available – see our website for details.

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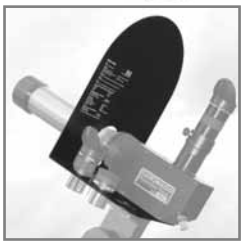
$45.99 £29.99 €62.00*

The Solar-Mate observing shade for Coronado PST AC599

New!



This combined observing shade and eyepiece holder will greatly improve observer comfort by minimising glare. It's a simple fact that a telescope offering a moderately dim eyepiece view like the Coronado PST will perform significantly better in terms of contrast and detail if steps are taken to reduce local glare. Our handsome glare shield is designed to cast a perfect shadow over the eyepiece region of the telescope and create a mini-environment for the observer to ensure that the eyes are always in a comfortable shadow when near the eyepiece. The rear face of the Solar-Mate is printed with a list of interesting "Solar facts". The Solar-Mate is easy to fit and requires no tools.

$34.99 £19.99 €38.00*

The AZTech altazimuth mount & wooden tripod AC562

Ideal for use with the Coronado PST

New!

The AZTech is an altazimuth mounting system with worm and gear hand-operated slow motions on both the azimuth and altitude axes. The mounting is fitted to a variable-height black hardwood tripod (fully adjustable from a minimum height of 91cm [36"] to a maximum height of 140cm [55"]). A metal combined leg stabiliser and eyepiece tray ensures the rigidity of the tripod. The leg stabiliser simply clips into position – no nuts and bolts to fiddle with and risk losing! The precision worm and gear sets offer smooth tracking on both axes even at high magnifications, and are supplied with extended flexible control handles.

The CNC-manufactured mini-dovetail telescope mounting plate has been specifically designed to fit the base of the Coronado Personal Solar Telescope, but can be used with a wide variety of small telescopes provided that they have a 1/4" Whitworth tripod fitting. Supplied complete with mini-dovetail plate for PST and other scopes, wooden tripod, eyepiece tray and extended flexible drive handles.

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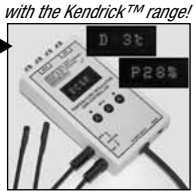

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Where are they?

I'm surprised your September cover

asked, "Is *anyone* out there?" For us to think we are the only life forms in a universe with trillions of suns is a monument to our arrogance. The question is not if anybody is out there, but where are they? In cosmic time and space, Earth is a dust speck, and the entire era of human existence is a nano-blip. Any signal from celestial intelligence will have taken thousands, if not millions, of years to reach us. Indeed, an electromagnetic transmission from the opposite side of our own Milky Way Galaxy would not arrive here for 54,000 light-years.

Even our "next-door" galaxy, Andromeda, is some 2 million light-years away. Thus, if the Search for Extraterrestrial Intelligence (SETI) and the new Allen Telescope Array do detect an interstellar signal, will it mean anything?

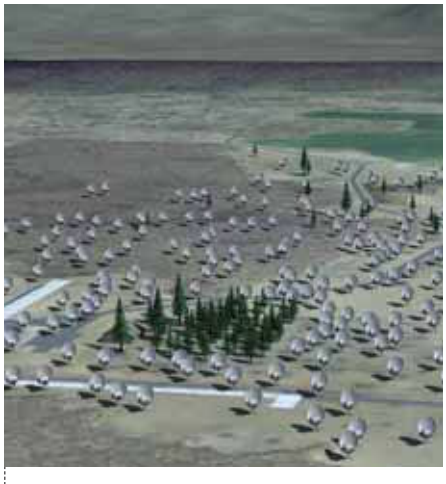
— FORREST G. WOOD, BAKERSFIELD, CALIFORNIA

How ironic that the "advanced" civilization depicted on your cover and in Seth Shostak's "Listening for a whisper" (September 2004) is awash in light pollution! Wouldn't an advanced species eliminate light pollution — especially a species with enough interest in astronomy to invest enormous amounts of time and capital in a Moon-size transmitter?

Would a truly advanced species even be dependent on visible light? Visible light comprises only a minute fraction of the electromagnetic spectrum; why not a species that "sees" in the infrared, or even in radio light?

To your credit, yours is not the only publication to assume that high technology invariably results in such wasteful world-girdling night-light; planets with darksides wildly aglow is a common theme in space art and science fiction. It's a sad commentary on our abysmally limited intelligence.

— TOM SMITH, SAN DIEGO



THE ALLEN TELESCOPE ARRAY will include 350 radio dishes 20 feet (6 meters) in diameter. When complete, the radio telescope will hasten the search for intelligence elsewhere in the universe. SETI

It is good to read that the search for extraterrestrial intelligent life is expanding its efforts. I have an objection to Seth Shostak's use of the word "failure," however, in referencing the to-date status of the SETI program. Such an undertaking can never be considered a failure. It's a big universe, and we have only just begun.

If we use words like this already, as if we should expect a rapid turnaround on investment (à la Jodie Foster in *Contact*), investors are sure to lose interest. Investors, be they private or government administrations, have short-term agendas and abhor failure. The pundits are correct in urging us to "rein in our expectations." Indeed, this is a "project for the generations," whether we find someone to talk to tomorrow or in 100 years.

As interested parties, it is our responsibility to foster the mindset that this is a long-term endeavor. Labeling something a failure just limits investment, and the enormous scope of a project with such a lofty goal as making contact with advanced extraterrestrials should not be forgotten.

— RICH CLARK, MILLERSVILLE, PENNSYLVANIA

Martian mystery

To me, Pot of Gold on Mars looks like a molten meteor that plowed into shallow water and went "splat" on the bottom (News, September 2004). The stalks with nodules are the splatters that hardened almost instantly in the cool water.

In my work with aquatic sediments, I've found molten metallic blobs of various sizes to be common wherever sand and stones collect. Some are old and rusty; some are full of bubbles trapped by rapid cooling; many are an iron and glass mixture. Others wrapped around the stones they landed on, like hot taffy, and got stuck that way.

The stalks and nodules, and the iron content, always distinguish these "stones" from the rest of the sediment. Pot of Gold looks very much like a larger version of these curiosities, only adding to the evidence that water once flowed on Mars.

— ANN R. WILLIAMS, BURLINGTON, VERMONT

Postscript

Regarding the caption on page 39 in "Listening for a whisper" (September 2004), we would like to clarify that Lick Observatory is located atop Mt. Hamilton in California and is run by the University of California Observatories, headquartered in Santa Cruz. — *ASTRONOMY* EDITORS

We welcome your comments. Send letters to Astronomy *Letters, P.O. Box 1612, Waukesha, WI 53187; e-mail to letters@astronomy.com. Please include your name, city, state, and country. Letters may be edited for space and clarity.*

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BY BOB BERMAN

Moon orbit oddities

We who love the night sky often

regard the Moon with mixed feelings. When full, it ruins almost everything else. Galaxies, nebulae — gone, washed out. The sky actually turns a deep blue during the three nights surrounding the Full Moon, if you're not under the amber canopy of urban glow. Yet even after committing felonies against us, the Moon doesn't provoke loathing. It gets a pass because it *is* a celestial body and *does* offer more juicy telescopic detail than anything else in the universe. It's love-hate.

The situation was different a mere century ago, when civilization was more agrarian and had few streetlights. Back then, a bright Moon permitted safe nocturnal travel while a moonless night was just plain dangerous. The Moon mattered. And it still was mysterious.

The best telescopic resolution couldn't determine what lurked among those craters and mountains. Nineteenth-century astronomers knew that, by coincidence, 1" of resolution revealed 1 mile of lunar real estate. Even now, a good telescope and a steady night with 1" of seeing let you see lunar detail as small as a mile across.

Throughout the ages, one aspect of the Moon could be explored by anyone with eyes: its motion. This single natural body that revolves around our world remained fascinating for that reason alone.

You'd think that nearly everyone, in the past and present, would be aware of the Moon's orbit. Yet in today's educated society, not one person in 100 knows even the basics about lunar activity. Of course, I'm bringing the subject up now because the Moon reaches a sort of orbital milestone this month.

So, let's start with those fundamentals. First, the Moon doesn't orbit our planet's center, but a spot just a thousand miles beneath Earth's surface. Where is that magic place? When the Moon is almost overhead, as it will be at midnight December 25/26, the exact spot it orbits lies a thousand miles beneath your feet.

Next, the Moon's orbit changes shape all the time. Around New and Full Moon, it becomes stretched out and eccentric. At other times of the month, it's more circular. Moreover, its oval shape keeps changing direction, advancing completely around Earth every 9 years. As a result, the Moon never returns to its starting spot or actually completes its orbit. Its real motion is similar to a rosette, a spirograph pattern, as if tracing out the petals of a daisy.

The Moon is the only known body that moves through space its own diameter each hour. With a 2,160 mile (3,476 kilometers) width and an average speed of 2,287 mph (3,680 km/h), it's easy for an observer to predict where it will be throughout its nightly journey.

This size-speed coincidence also explains why both lunar and solar eclipses take about an hour from start to totality.

The Full Moon is 450,000 times dimmer than the Sun. It grows brighter, however, when it's higher because it's then closer to you by a few percent, and also because its light then passes through up to 13 times less air. It's brighter when the air is dry also. All these conditions come together late this month.

I've saved the best for last. The Moon does not orbit around Earth's equator. Unlike how every other major moon circles every other planet, our Moon ignores Earth's tilt and circles us in the same ecliptic plane in which planets orbit the Sun. Doing so, its path slowly wobbles like a dropped dish rattling on the floor, taking 18.61 years to perform a complete wobble. The consequences are dramatic.

This wobble causes the Moon's 5° tilt relative to the Earth-Sun plane to change alignment during that 18.61-year period. Result: Some years, its monthly path around the sky carries it *under* where the zodiac is highest and *above* where the zodiac's the lowest. Those years, like during the mid-1990s, the Moon is in middling positions and Full Moons never get as high as early summer Suns.

Now, however, we've entered the 3-year period when winter Full Moons (always the highest of the year) get loftier than usual. You'll see this December 25 — the highest Full Moon of the year. (If it's cloudy, look the next night.) Check it out around midnight. It's the highest Moon since the 1980s.

Will anyone else notice? Not likely. Despite our expensive plans to return there someday, the truth is few bother with the Moon. Oh well. Love-hate.

> { ... our Moon ignores Earth's tilt and circles us in the same ecliptic plane in which planets orbit the Sun.

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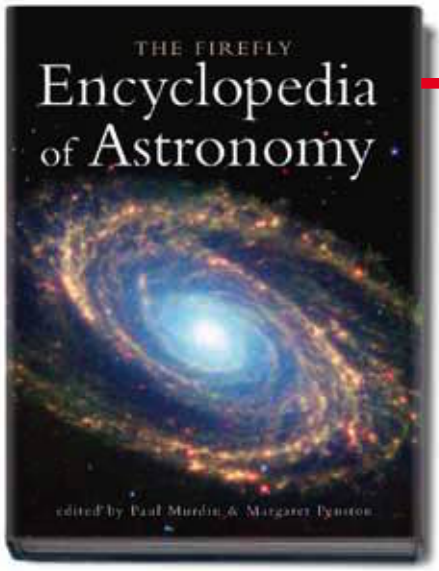

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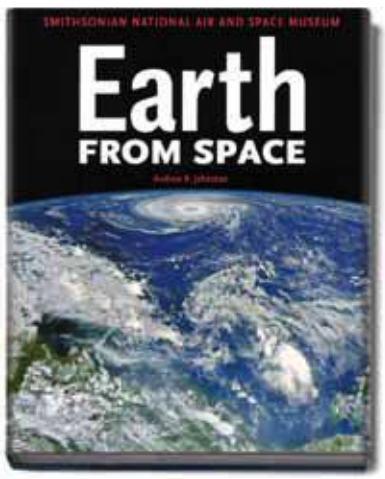

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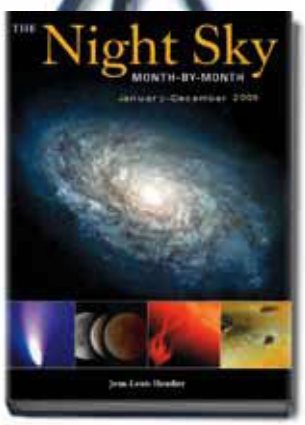

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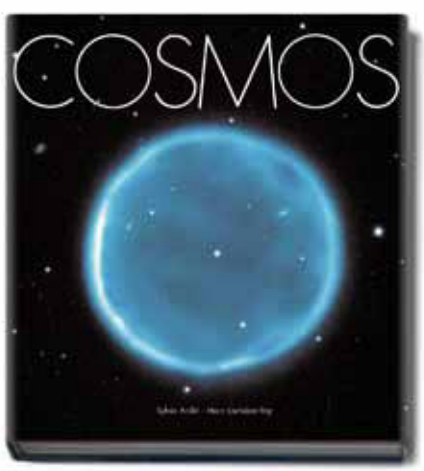

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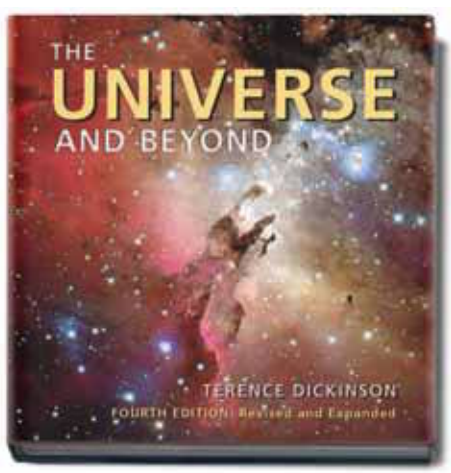

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BY GLENN CHAPLE

Holiday wish list

Here's a question for you astronomy newcomers out there: What's the most important item a beginning skygazer should purchase? If you answered "A telescope!" I'm sorry to say you're wrong. Oh, it's up there in degree of importance, but a telescope alone won't get you very far — at least, not at first. Here's a list of

essentials to help launch your cosmic odyssey. (It's no coincidence that I'm doing this in the December issue, hint, hint.)

1. A subscription to *Astronomy*

If you're not a subscriber, get onboard! Besides how-to articles (like this column) and information on what's currently visible in the night sky, you'll get updates on the latest astronomy news as well as helpful product information.

2. A sky calendar

Astronomy's *Deep Space Mysteries 2005* calendar adds astronomical events to the usual holiday information for each month. When the year is over, you can cut out, frame, and mount those beautiful monthly sky photos, and order your 2006 calendar.

3. An annual observer's guide

Astronomy's *Explore the Universe 2005* combines a month-by-month list of important sky events with useful how-to articles. This and the previous two items make a great gift package for any astronomy enthusiast, beginner or veteran.

4. A star and constellation guidebook

If you're unfamiliar with the major stars and constellations, you and your telescope will become "lost in space." My favorite constellation primers are Chet Raymo's *365 Starry Nights* and H. A. Rey's classic *The Stars — a New Way to See Them*.

5. A planisphere

This handy gadget shows the visible stars and constellations for any date and time of year. Not only does a planisphere familiarize the novice with the night sky, it's a valuable tool for the expert who wants to plan an observing session.

NO HOLIDAY GIFT PACKAGE for the amateur astronomer in the family is complete without these essentials. *ASTRONOMY*: BILL ZUBACK

6. A star atlas

More detailed than a planisphere, a star atlas provides the "meat and potatoes" information about deep-sky treats in each constellation. Two nice entry-level atlases to help hone your search for deep-sky objects are the Edmund Scientific *Mag. 6 Star Atlas* and Wil Tirion's *Bright Star Atlas*.

7. A Moon map

The Moon is the logical first telescopic target for the beginner. But how do you identify all those mountains and craters? That's where a high-quality Moon map comes in. Edmund Scientific offers a nice laminated Moon poster/map for $6.95.

8. An amateur astronomy handbook

You'll want a how-to guide that covers the basics of backyard astronomy. Among the many user-friendly versions available, I recommend *Nightwatch* by Terence Dickinson and *Skywatching* by David Levy.

9. A logbook, clipboard, and pencils

A carefully kept logbook (a three-ring binder with pages for sketches and notes of your observations) will become a valued resource. The clipboard will provide a hard, flat, portable surface for writing your notes and drawing your sketches. Look for my tips on setting up and keeping an observing logbook next month.

10. A flashlight

Without a flashlight, you can't read those star charts or perform emergency "surgery" on your telescope. To preserve your night vision, place red cellophane over the lens before you go out to observe. A red LED astronomer's flashlight will cost more, but it also will be more effective.

11. Binoculars

This item bridges the significant gap between naked-eye observing and telescope observing. A good choice is the 7x50 size (7x is the magnifying power, and 50 is the diameter in millimeters of each front lens). This and a copy of Phil Harrington's *Touring the Universe Through Binoculars* will reward you with many evenings of cosmic adventure.

12. Telescope

Only after you've learned the constellations and have kept a detailed logbook of observations made with the naked eye and through binoculars are you ready for your first telescope. For great advice on purchasing your first telescope (and accessories), invest in a copy of Phil Harrington's *Star Ware — Third Edition*.

To find some of the items listed above, check with the companies that advertise in this magazine. Also, stop in at your local book store or camera shop.

Questions, comments, or suggestions? E-mail me at *gchaple@hotmail.com*.

Next month: hints for keeping an astronomy logbook. Clear skies.

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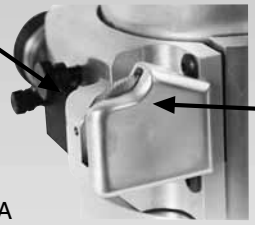

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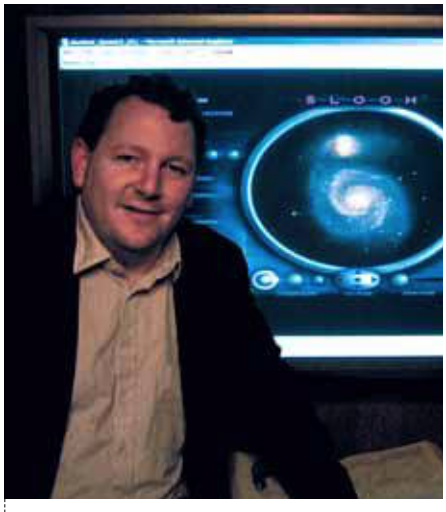
BY WILLIAM SCHOMAKER

Michael Paolucci

Michael Paolucci isn't your average

astronomy advocate. The eternal entrepreneur has made it his business to bring the universe straight to your desktop. Paolucci is the founder and president of SLOOH, an on-line astronomy community that grants live telescope time to anyone with access to the Internet. SLOOH's robotic scopes enjoy the pristine observing conditions of Mount Teide, on Tenerife in the Canary Islands — a deal that took Paolucci more than a year to negotiate with the Institute of Astrophysics of the Canary Islands.

Paolucci also started *SaveTheHubble.org* in response to NASA's decision to scrap future servicing missions to its flagship, the Hubble Space Telescope. Due to the overwhelming response, including more than 40,000 signatures of protest from Paolucci's site, the agency is considering robotic servicing missions. As an *Astronomy* reader, you can enjoy a sample tour of SLOOH. Visit *www.astronomy.com* for details.



MICHAEL PAOLUCCI and SLOOH let you use state-of-the-art telescopes from the comfort of your own home. HENRY DAVIS

How does SLOOH, as you say, bring back the intended use of the Internet?

SLOOH is the kind of highly interactive application that can only be utilized on a computer connected to the network — you couldn't experience it in any other medium. It is essentially a high-tech co-op, giving groups of dispersed people the opportunity to pool their resources to control powerful and expensive equipment they otherwise would not have access to. That is very different from the kind of Internet content designed for other media such as TV that was just being re-purposed for the Internet.

What was its genesis?

I first had the idea in 2000. I am interested in astronomy but live in New York City, probably the most light-polluted place on Earth, and generally, I don't have the time to investigate the night sky as I would like. As an entrepreneur, I thought if I could remove the hurdles most people face in setting up their own telescope — light pollution, poor weather, expensive equipment — I could open up astronomy to a much larger segment of the population. This, in turn, would enlighten society as a whole, as more and more people would get exposure to the amazing scientific discoveries of the last 100 years.

What were some of the biggest obstacles to getting SLOOH on-line?

The first major obstacle was finding a professional observatory that would host us. I went to Chile, Hawaii, and Europe and ended up deciding that the site in the Canary Islands would serve our purposes the best, given that the time-zone shift would make SLOOH available to kids in the United States before bedtime. The leadership of the Institute of Astrophysics is also very committed to educational outreach, and they considered SLOOH to be a unique way to show people the kind of science they do up on the mountain.

From a technical point of view, the hardest part in setting up a robotic telescope is in making it reliable, so that from 3,000 miles away, up on the mountain, where the wind blows [more than] 100 miles an hour in winter, you can operate day in and day out.

Where is SLOOH headed?

It may sound corny, but we'd like SLOOH to become a community of the world, a place where people [of] every nationality and religion can come to relate to one another about something they all have in common, namely mankind's relative position in the universe. To that end, we'd like to add a second telescope site to expand our hours of coverage, and to add a language tool that facilitates interaction among our members.

How does it feel to see that your lobbying efforts to save Hubble are paying off?

I am pleased to see that NASA has responded so aggressively to the demands of [its] constituents. I think they lost sight for a moment of just how important Hubble has been in capturing society's imagination for space, aside from its incredible legacy as a tool for science. It is clear now, though, that the best minds among us are thinking about how to extend Hubble's life, and I am confident they will come up with an appropriate solution.

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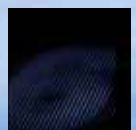

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13mm T6	240
16mm T5	270
17mm T4	330
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22mm T4	390
26mm T5	490
31mm T5	530

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15mm	210	19mm	240
22mm	280	24mm	295
27mm	330	35mm	365

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1.25" 2x or 3x	105
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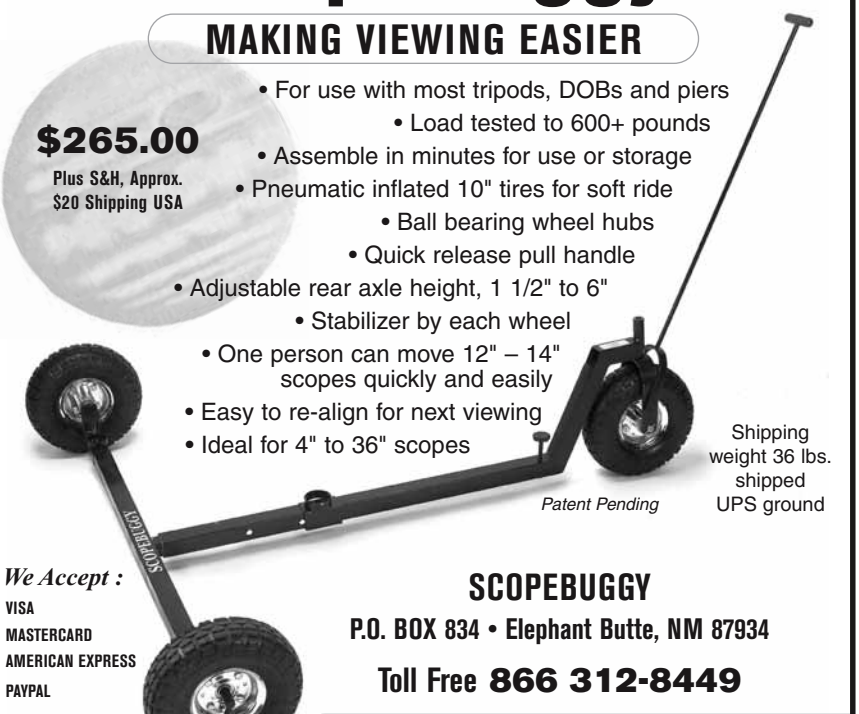

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DSLR II shown on a Canon 10D*

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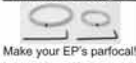

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No Purchase Necessary. The official start date for the Astronomy Winter 2004 Sweepstakes is September 24, 2004. Official entry forms are bound in the November, December 2004 and January 2005 issues of Astronomy. The Astronomy Winter 2004 Sweepstakes is open to residents of the United States and Canada (except Quebec) only, 18 years of age or older. Employees (and their dependants and immediate household members) of Kalmbach Publishing Co., their advertising and promotional agencies, and participating sponsors are not eligible to participate.

Sweepstakes Entry. To enter, complete and mail the official entry form or a postcard with name, address, city, state or province, zip and telephone number on a postcard and sent it to: Astronomy Winter 2004 Sweepstakes, P.O. Box 378, Waukesha, WI 53187-0378. Or enter online at www.astronomy.com by filling in the Online Entry form and hitting the SEND key. The Online Entry form must be filled out completely to be eligible. Incomplete or defaced entry forms are void. One entry per household. The official ending date for the Astronomy Winter 2004 Sweepstakes is January 7, 2005, and all entries must be transmitted or postmarked no later than that date.

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Validation and Acceptance. Winners in the Astronomy Winter 2004 Sweepstakes will be selected in a random drawing conducted by an independent judging organization whose decisions are final. Canadian prize awards subject to skill test requirement. By entering the sweepstakes, participants agree to be bound by these official rules and all decisions of the judging organization. Sweepstakes entries void if not legible, not completed in full, not obtained legitimately, or if forged, photocopied, mechanically reproduced, late or tampered with. The potential winners must sign and return an Affidavit of Eligibility, publicity release and Release of Liability within fourteen (14) days of notification. In the event of noncompliance, alternate winners will be randomly drawn. No responsibility is assumed for lost, stolen, misdirected or late entries or notifications. All sweepstakes entries become the property of the sponsor and will not be returned.

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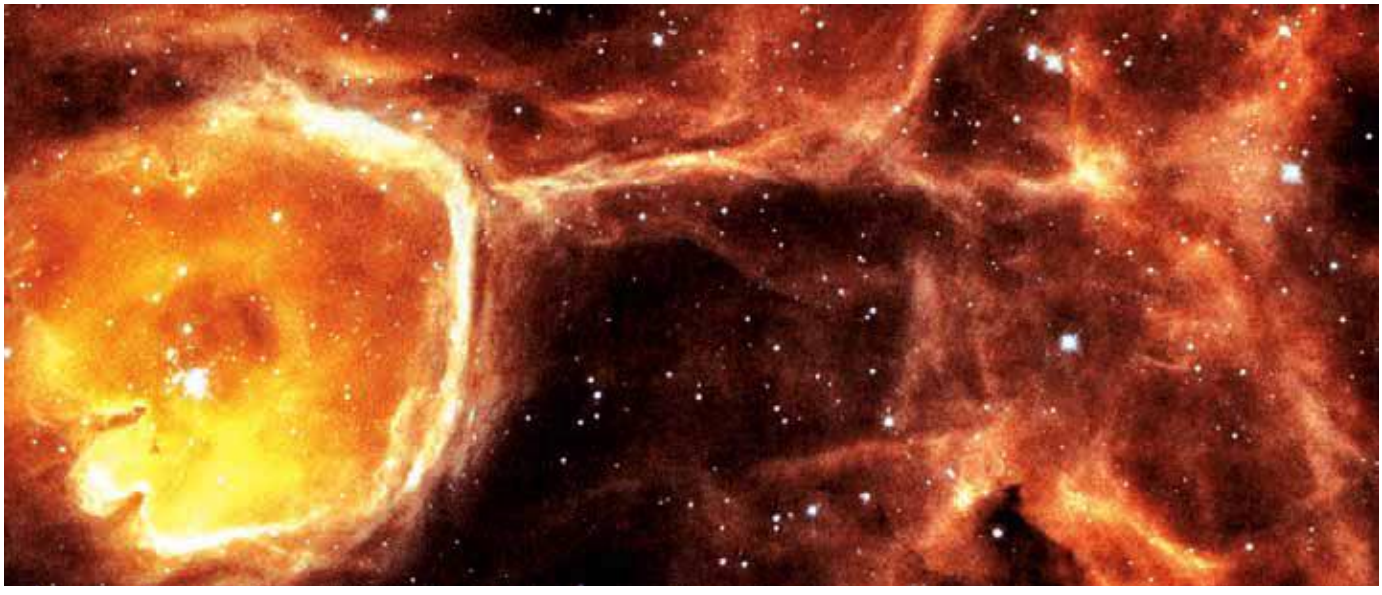
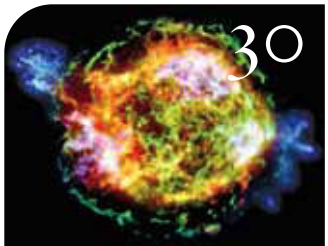
PRECISION TRACKING during the launch of the Mercury probe MESSENGER showed NASA that imaging radar can monitor shuttle launches closely and spot damaging debris falling from a booster immediately.

news 12

Read all about it: giving the space station a better view, how tiny telescopes found a big planet, a mission to hit a comet, clocking the Milky Way's age, and a possible way to communicate with extraterrestrials.



GLOWING CAVERN Hot, young stars have blown a bubble within a rich star-forming region in the Large Magellanic Cloud, a satellite galaxy of the Milky Way. Astronomers used the Hubble Space Telescope to take this image as part of a study of how stars are born from interstellar clouds of gas. ESA/NASA



30 Jets shooting out of a supernova remnant

32 Tiny telescopes find a big exoplanet

34 Slithering Mars dunes

36 Send ETs a message-in-a-bottle

STAR FORMATION

Star carves hollow in gas cloud

Astronomers using the Hubble Space Telescope's Wide-Field and Planetary Camera 2 have imaged the star-forming region N44F. This is one of several such regions within the N44 complex in the Large Magellanic Cloud.

The region shown above contains a hot, young star that has blown a bubble in the interstellar medium about 35 light-years across. (The image as a whole spans about 100 light-years.)

The young star is so hot it sheds material at a rate 100 million times faster than the Sun. Blowing at 4 million miles (7 million kilometers) per hour, this "wind" has pushed back the walls of dusty gas within the surrounding cloud, opening it to our view.

The image shows the inside walls of the interstellar bubble with fingers of gas 4 to 8 light-years high. These resemble the famed "pillars of creation" the Hubble Space Telescope saw in the Eagle Nebula a decade ago. Each finger likely contains a star in the process of formation whose birth nebula is being eroded by the radiation from N44F's hot central star.

The Large Magellanic Cloud has had a turbulent star-forming history — see News, *Astronomy*, October 2004. — ROBERT BURNHAM

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SPACE TRAVEL

Better views in space

A ceremony September 6 in Italy marked the completion of a European-built cupola destined for the International Space Station (ISS).

The module's windows will provide panoramic views for astronauts controlling the station's robotic arm and conducting Earth observations and other science.

The addition also will house hardware crew members can use to communicate with each other inside the station and during space walks.

The project was a barter between the European Space Agency (ESA) and NASA; ESA built the cupola in exchange for NASA taking equipment to ISS aboard the shuttle.

FANTASTIC SIGHTS The new cupola for ISS will provide astronauts with great views when it's installed. NASA

After the module is transferred to the Kennedy Space Center in Cape Canaveral, Florida, it will receive a final set of checks and then be put into storage. Launch is slated for January 2009. — LAURA BAIRD

PLANETARY SCIENCE

Mars Odyssey working overtime

The Mars Odyssey orbiter, which has found (among other discoveries) large amounts of ice in relatively warm regions on Mars, has had its mission extended by NASA for a second martian year.

"During the prime mission, we tracked seasonal changes, such as the comings and goings of polar ice, clouds, and dust storms," says project scientist Jeff Plaut. "We have begun watching for differences."

Extension lets Odyssey support the Spirit and Opportunity rovers, most of whose images are relayed to Earth via the orbiter. — JEREMY McGOVERN

MARS VOLCANO Hecate Tholus was imaged by Odyssey's THEMIS instrument. NASA/JPL/ASU

SUPERNOVAE

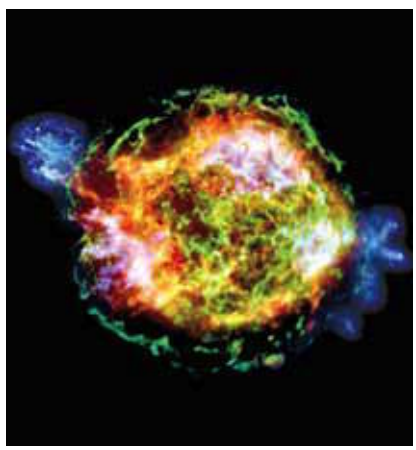
Chandra finds jets in Cassiopeia A

Astronomers using the Chandra X-ray Observatory took the most-detailed image yet of supernova remnant Cassiopeia A. The 11.5-day exposure revealed two jets.

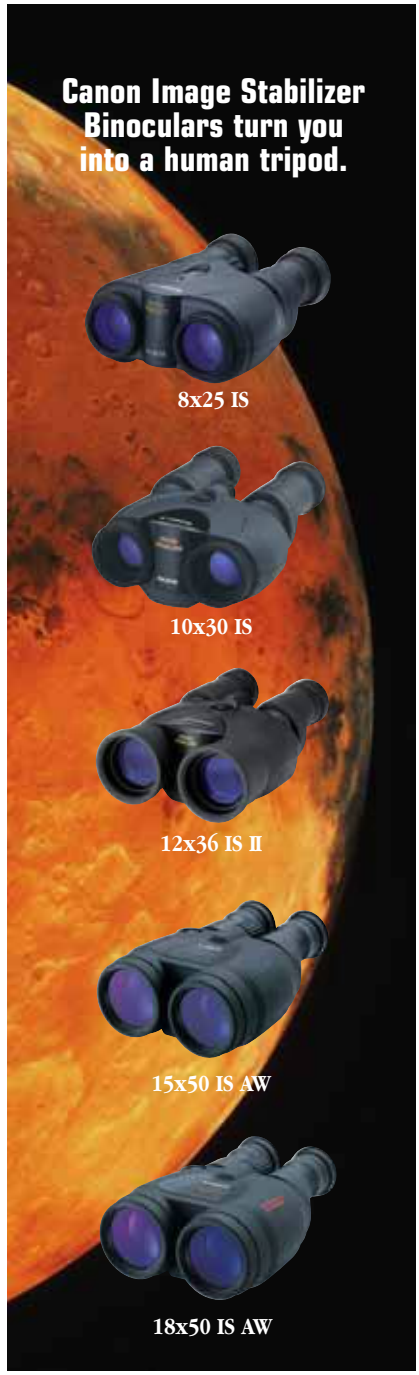
The discovery hints the progenitor star, weighing 20 to 25 solar masses, detonated in a way resembling a gamma-ray burst, but with less energy.

"The presence of the bipolar jets suggests jets could be more common in supernova explosions than astronomers suppose," says Una Hwang (Goddard Space Flight Center), who led the team making the discovery.

Cassiopeia A went supernova in 1680 and has been studied at all wavelengths from radio to high-energy gamma rays. — R. B.



STELLAR BLOWOUT Jets of silicon (blue) reach more than 10 light-years from the center of supernova remnant Cas A. The green ring is the shock wave; colors indicate energies, bluer being higher. CXC/F. REDDY



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Never again in our lifetimes will the Red Planet be so spectacular. But if you missed it because you had the wrong equipment – or worse, none at all – you'll have to wait until 2287 to see Mars that close again. Of course, there are about a billion trillion other objects out there that make for spectacular viewing. And there is an entire range of Canon cameras and equipment that can make it more rewarding. A pair of Canon Image Stabilizer Binoculars is a great place to start. Like the Canon **18x50 IS AW** and the **15x50 IS AW**, which feature genuine Canon optics for amazing sharpness and contrast, with virtually distortion-free clarity. The IS Series features a unique Doublet Field-Flattener and Super Spectra Coatings for superior image quality. And with Canon's Image Stabilizer system, a microcomputer calculates the amount of shake, which is then counteracted by either a set of Vari-Angle prisms or a tilt mechanism, keeping the stars and planets from bouncing all over the place. When it comes to astrophotography, a Canon EOS Digital SLR, like the **EOS 20D** or the **EOS Digital Rebel**, is just the thing. Their low noise at long exposure times and low shutter lag make the 20D and Digital Rebel the perfect accessories to your telescope, when combined with a telescopic adapter. And with their **CMOS** sensors and Canon's exclusive **DiG!C** chip, you get incredible detail with low power consumption. Attached to a quality telescope, a Canon Digital SLR will enable you to take photographs beyond your wildest dreams.

Mars hadn't been this close to Earth in 60,000 years. Yet it's amazing how many people missed it.

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EXTRASOLAR PLANETS

Tiny scopes find big planet

SMALL SCOPES, BIG REACH An array of 4-inch telescopes detected an exo-Jupiter crossing in front of its star. CFA/D. AGUILAR ARTWORK

Astronomers have announced that a far-flung array of three 4-inch (10 centimeter) telescopes has discovered a Jupiter-size planet by sensing a slight dimming as the planet passes in front of its star. The telescopes make up the Trans-Atlantic Exoplanet Survey (TrES) and are modified versions of those available to backyard astronomers.

The survey has a telescope in the Canary Islands, one at Lowell Observatory in Arizona, and one on Palomar Mountain in California. The geographical spread lets astronomers monitor targets longer than any one telescope could.

The array uses 4-inch Schmidt telescopes equipped with CCD cameras and an automated search routine that surveys relatively bright stars. The new planet, dubbed TrES-1, has Jupiter's size but only three-fourths its mass; every 3.03 days, it orbits its unnamed home star, which lies about 500 light-years from Earth.

The star was one of 16 identified by the TrES team as having a possible exoplanet. Follow-up observations using larger telescopes (including the 10-meter Keck at Mauna Kea) confirmed the find.

The survey was created by David Charbonneau (Center for Astrophysics), Timothy Brown (National Center for Atmospheric Research), and Edward Dunham (Lowell Observatory). The lead author on the paper reporting the discovery is grad student Roi Alonso (Astrophysical Institute of the Canaries, Spain); the team plans to publish its results in *Astrophysical Journal Letters*. — R. B.

Putting the touch on a comet

It's good that asteroids and comets are covered with impact craters, so new ones won't much alter the landscape. Space vehicles have been smashing into other worlds since the 1950s, digging small, new craters for science, and the galaxy's Environmental Protection Agency hasn't complained yet.

That's good news, because in late December, NASA will launch a probe to do some fairly heavy excavation on Comet Tempel 1.

After launch, the Deep Impact probe will cruise for 6 months before intercepting the comet beyond Earth's orbit. On July 4, 2005, the probe will fling a self-guiding, camera-carrying kamikaze warhead into the comet. The impact speed alone — more than 6 miles per second (10 km/s) — guarantees a tremendous explosion, about the same as 5 tons of TNT. The mother ship will make observations as it cruises past during the next 15 minutes, protected from flying debris by a dust shield.

For scientists, the impact flash will tell spectrometers on the probe (and back on Earth) much about the comet's composition, both its surface and deep inside. The size of the crater — perhaps as big as a football stadium — and the size of pieces knocked off will tell about the comet's strength.

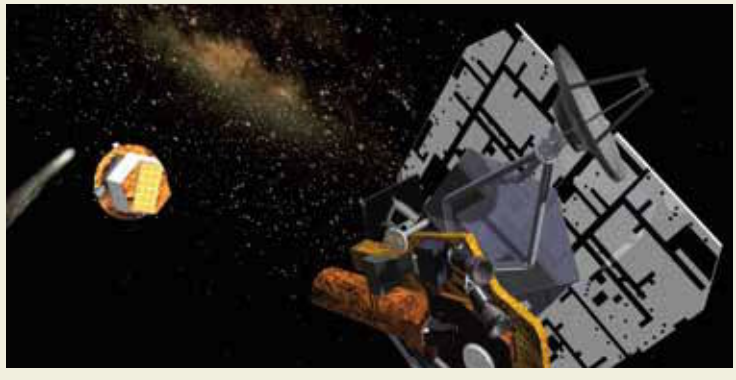
The expanding dust cloud should increase the comet's visual brightness and may be detectable in backyard telescopes.

To reduce the chance of the impactor's materials being mistaken for cometary components, mission scientists built the impactor using substances unlikely to occur naturally in a comet — it's half copper by weight, for example.

Along with a spectrometer, the mother ship carries two instruments for observing the impact at visible-light wavelengths. One instrument has a field of view of half a degree, providing a resolution of about 33 feet per pixel (10m), while a high-resolution imager is five times sharper.

The collision will have an undetectably small effect on the comet's orbit. Measuring these effects is for another mission, another day. (One such is in the pipeline: the European Space Agency's Don Quijote mission to hit an asteroid; see News, *Astronomy*, October 2004.)

Deep Impact's goal is to get inside a comet and see what it's made of. Its results should greatly enhance our views of all comets.
— JAMES OBERG



COLLISION COURSE An 800-lb copper impactor heads for Comet Tempel 1, as the Deep Impact flyby probe (right) prepares to study the smash. NASA ARTWORK

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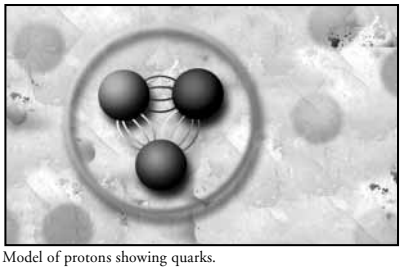

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Steven Pollock (Ph.D., Stanford University) is Associate Professor of Physics at the University of Colorado at Boulder. He has taught physics courses from introductory physics to advanced nuclear and particle physics. He received the Boulder Faculty Assembly Teaching Excellence Award in 1998. He became a Pew/Carnegie National Teaching Scholar in 2001. He is author of *Thinkwell's Physics I*, a CD-based textbook.

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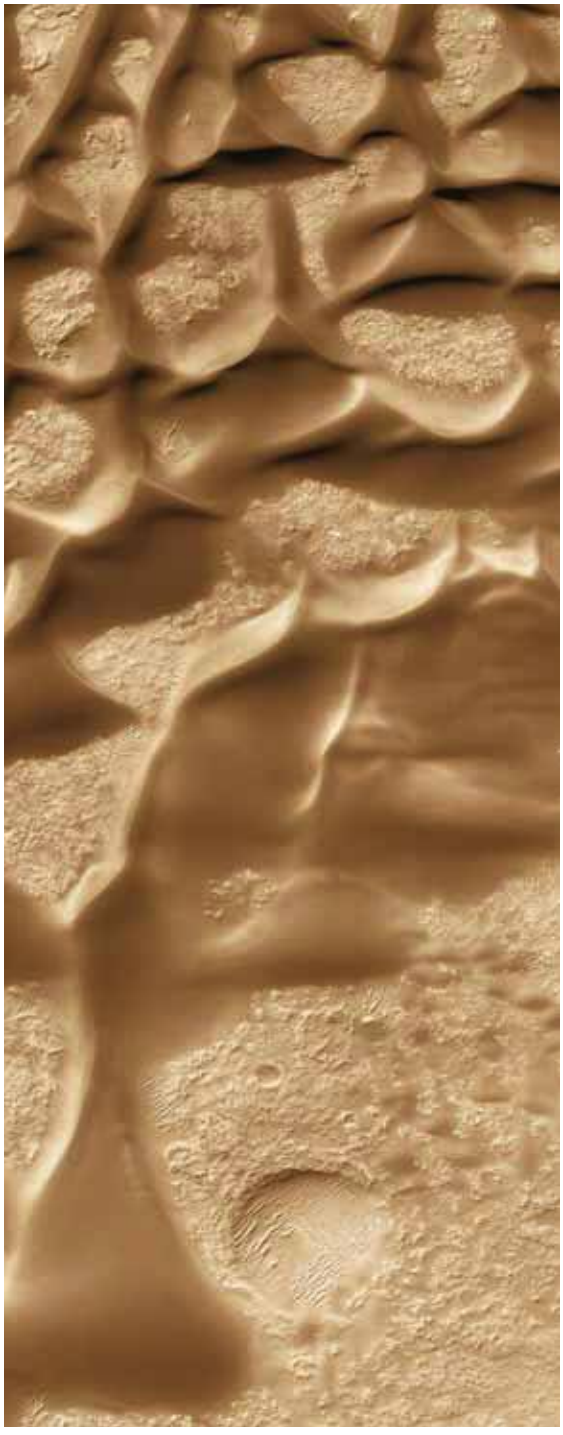
THE BEAGLE 2 MARS LANDER crashed on landing in December 2003. Inquest findings, made public in August 2004, were inconclusive. Possible culprits, however, include a martian atmosphere less dense than expected.

Bunge Crater dune field



SLITHERING SANDS Dark wind-sculpted dunes are both engulfing and uncovering older features, including light-colored dunes caught in craters and other hollows. Sunlight falls on the scene in Mars's Bunge Crater from the upper left; the image is about 1.9 miles (3 km) across. NASA/JPL/MSSS/IMAGE M22-00197

GALACTIC ASTRONOMY

Milky Way's age

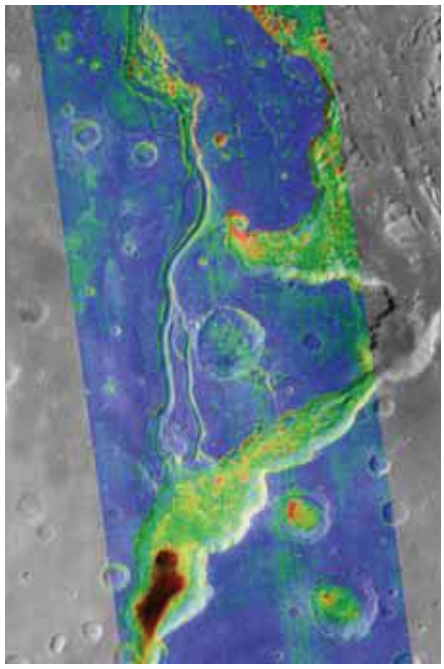
New studies of the element beryllium in globular cluster stars give the age of both the cluster and the Milky Way, says a team of astronomers led by Luca Pasquini (European Southern Observatory, ESO).

Pushing observational techniques to the limit, the astronomers used an 8.2-meter telescope at ESO to make the first measurement of the beryllium content in two stars in NGC 6397. From the amount of the element, the researchers calculated 200 to 300 million years elapsed between the formation of the Milky Way's first stars and those in the cluster.

Stellar evolution theory says the cluster's stars are now 13.4 billion years old. Adding the beryllium date to this yields an age for the Milky Way of about 13.6 billion years.

Studies of the microwave background radiation give the universe a total age of roughly 13.7 billion years. This means the Milky Way's first generation of stars formed soon after the Big Bang. — R. B.

MARS PHOTOJOURNAL



HEAT OF THE NIGHT Mesas in Shalbatana Vallis are cool and dusty (blue), while warmer pockets of rocky terrain (green and red) line the valley floors and walls. This image lays a Mars Odyssey nighttime infrared view on a visible-light MOC image from Mars Global Surveyor. The view is about 160 miles (260 km) wide. NASA/JPL/ASU

PLANETARY SCIENCE

Down in Endurance Crater

CURIOUS CRACKS Mars rover Opportunity imaged a rock containing what look like mud cracks (right). The rock at left is dubbed "Escher." NASA/JPL/CORNELL/IMAGE 1N146478875EFF35B8P1981

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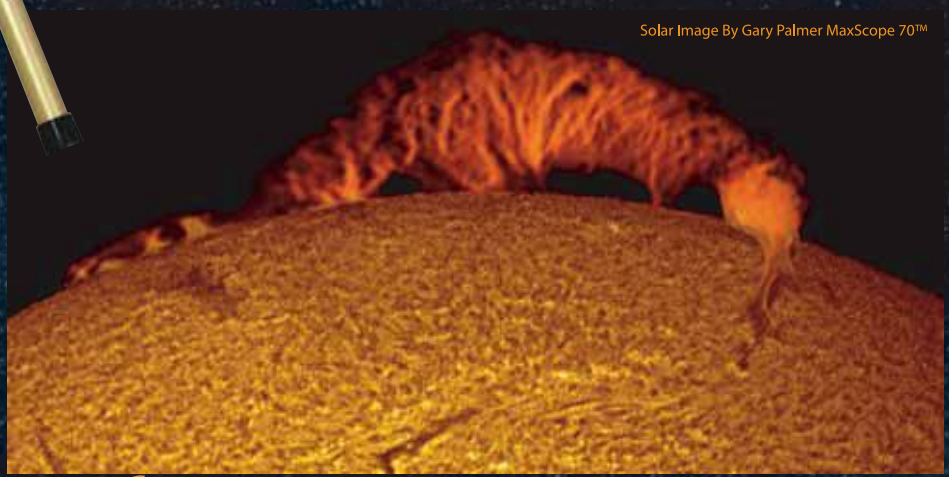

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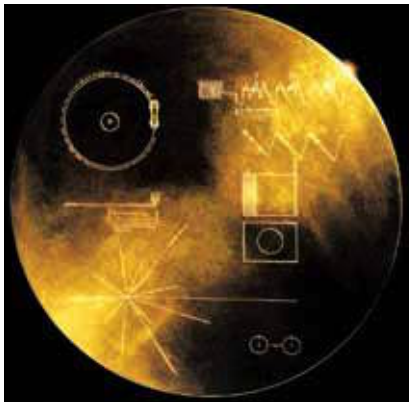

WE'RE HERE The LP record aboard each of the two Voyager spacecraft holds 115 images, natural sounds, music from different cultures, and spoken greetings from humans. NASA/JPL

If aliens from a distant solar system want to make their presence known to us, they'd do better to write than to phone — that is, to send something more like the Rosetta Stone than a pulse of radio waves, a new study suggests.

The study, by Christopher Rose and Gregory White (Rutgers University), looked at the energy efficiency of long-distance communication. The results "suggest that our initial contact with extraterrestrial civilizations may be more likely to occur through physical artifacts — essentially messages in a bottle — than via electromagnetic radiation," the authors write. Their paper appears in the journal *Nature* (September 2, 2004).

The reason most discussion of interstellar communication has focused on electromagnetic signals, the authors explain, is that it was usually taken for granted messages would be short and that speed was of the essence — that is, that a prompt reply was desired. But if that's not the case — if you're sending a long and complex message, and you're not worried about the amount of time it might take to reach its destination — then a physical message is the most efficient choice, the authors say. — DAN FALK

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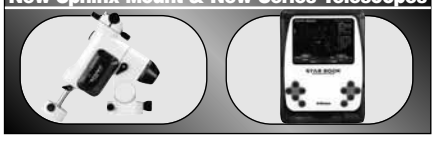

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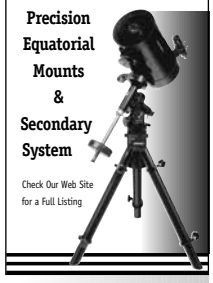

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KILLER IMPACT

NASA has detailed plans for saving the planet in case an asteroid is discovered coming our way, right? The answer probably will surprise — and dismay — you. /// BY BILL COOKE

Do you remember *Armageddon* or *Deep Impact*? Those disaster movies from the late 1990s continue to thrill legions of home viewers with their stories of space-borne heroes risking life and limb to save Earth from a catastrophic collision with a comet or asteroid.

As an astronomer, I greet such movies with a mix of enthusiasm and resignation. I'm enthusiastic because I look forward to being entertained — and because bits of good science lie scattered between the fictional space shuttles "slingshotting" around the Moon and the absurd, crackly, crystalline comet surfaces.

The resignation sets in when I think of all the time I'll spend answering two basic questions provoked by such films: "How often does Earth get hit by an asteroid?" and "What can we do to prevent the collision?" The first question has

WAYWARD ASTEROIDS STRIKE EARTH from time to time — for example, the modest-size one that killed the dinosaurs. Astronomers trying to discover asteroids capable of the greatest destruction expect to meet their survey goals within a few years. Yet a large fraction of smaller asteroids, which cause less damage but strike more often, will remain undetected. *ASTRONOMY:* ROEN KELLY

NEAR-EARTH ASTEROID EROS is 21 miles (33 kilometers) long and has come within 20 million miles (32 million km) of Earth. While Eros will not collide with Earth anytime soon, the impact of a body this large would place the future of all humanity in jeopardy. Scientists hope any asteroids on impact courses will be discovered decades ahead of time, giving us a chance to divert them. NASA/JHUAPL

an answer based in statistics that I'll get to in a moment. Meanwhile, let's focus on the second question.

The answer to "What can we do to prevent the collision?" is very simple: nothing, at least for the foreseeable future. NASA has no nuclear-powered manned spacecraft and no zero-gravity mining equipment, such things being decades away. If an asteroid or comet were discovered on a trajectory ending in Earth-impact within the next few years, it would hit, and humankind would just have to deal with the consequences. We have nothing now to stop such a collision. End of answer.

But suppose we change the question slightly to "What can be done to minimize an impact's damage?" The answer to this question is far more substantial because actions are being taken — right now, this year — to reduce the risk of becoming a casualty of an asteroid strike.

Target Earth

Imagine someone outside on a wintry day with a big pile of snowballs handy. After being blindfolded and pointed in the direction of a target by a friend, the person commences throwing snowballs. The friend stands nearby, noting whether each throw hits or misses. Naturally most are misses, as each throw has a pretty small chance of hitting the target. But every now and then, the thrower will succeed, given enough snowballs.

Earth is in a similar situation with regard to near-Earth objects, or NEOs. Nature is blindly throwing rocks at our planet and once every great while manages to score a hit. There's an important difference, however, in that while all the snowballs are roughly equal in size, nature's collection of NEOs includes asteroids of all sizes, with the population getting more numerous as their size shrinks. Therefore, when nature throws an object our way, a small asteroid 100 meters (100 yards) across is much more likely than a "dinosaur killer" 10 kilometers (6 miles) across. (In fact, a 60-meter rock came down over the Tunguska River in central Siberia as recently as 1908.)

Scientists use counts of craters on the Moon, paleontological records of mass extinctions, studies of the orbits of discovered NEOs, and satellite measurements of upper-atmosphere explosions to determine how often Earth is hit. The most recent results are shown on page 43. Note that an asteroid 1 kilometer across (delivering an explosive power equal to 20,000 megatons of TNT) hits us every few million years, whereas a 100-meter rock (20 megatons) can strike every thousand years or so. Put into more meaningful terms, a person living to the age of 100 has about a 1-in-10 chance of a 10-megaton Tunguska-like impact occurring somewhere on Earth at some time during his or her life. Of course, the odds of being hurt by such an event are vastly lower — by roughly a factor of 50,000 — because the asteroid would have to strike nearby to cause injury.

As we go down the scale of energy, the odds of an impact go up, with 5-kiloton events occurring about every year. These impacts have about a third the energy of Little Boy, the bomb that was dropped on Hiroshima at the end of World War II. A hundred of these events should occur each century, and some of them (about 25 percent) should occur over land. So why aren't we seeing mushroom clouds in the sky every 4 years or so?

Earth's "flak jacket"

We've all heard of the ozone layer, the part of the atmosphere that blocks much of the Sun's ultraviolet radiation, thereby protecting people from

Bill Cooke *is an astronomer and meteor researcher with NASA's Marshall Space Flight Center in Huntsville, Alabama.*

being baked crispy while outdoors. Few realize Earth's atmosphere shields us from other cosmic dangers — like meteoroids and small asteroids. It's the reason you can go outside and enjoy a meteor shower without worrying about being bonked on the head. It's also the reason there isn't a yearly mushroom cloud produced by a meter-size rock hitting us at 40,000 mph (65,000 km/h).

In the case of meteors, the object's entry speed generates friction with atmospheric gas molecules that slows and heats the meteor. The meteoroid's surface temperature can reach thousands of degrees Fahrenheit, causing it to melt and vaporize. Thus a meteoroid loses a substantial amount of mass before finally slowing to the point where this ablation process stops. Most meteoroids, like those associated with meteor showers, are tiny, fragile, ice-dust mixtures from comets and stand little chance of reaching the ground.

Bigger objects, like small asteroids, experience ablation as they pass through the air, but a more important effect comes into play. As an asteroid penetrates the atmosphere, pressure rapidly builds on its front side, while the pressure in its rear, or wake, is essentially zero. If the pressure difference exceeds the ability of the asteroid to resist being crushed, it will break into fragments. The fragments, being smaller, have a greater crushing resistance and penetrate deeper into the atmosphere before being smashed into still smaller fragments. Some may even make it to the ground as meteorites. The whole cascading sequence can unfold over a handful of seconds.

University of Arizona researcher Jay Melosh and others have used computers to model how asteroids cope with atmospheric entry. They found that a typical stony NEO must be about 100 meters in diameter to make it through the atmosphere intact. Objects smaller than this will fragment like the meteor that broke apart some 11 miles (18 km) up, just before midnight March 26, 2003. The 1.6-meter stony asteroid scattered many pieces throughout the Chicago suburb of Park Forest. Darn good thing, too, for if this meteor had struck intact, it would have produced a one-third-kiloton explosion, devastating the neighborhood.

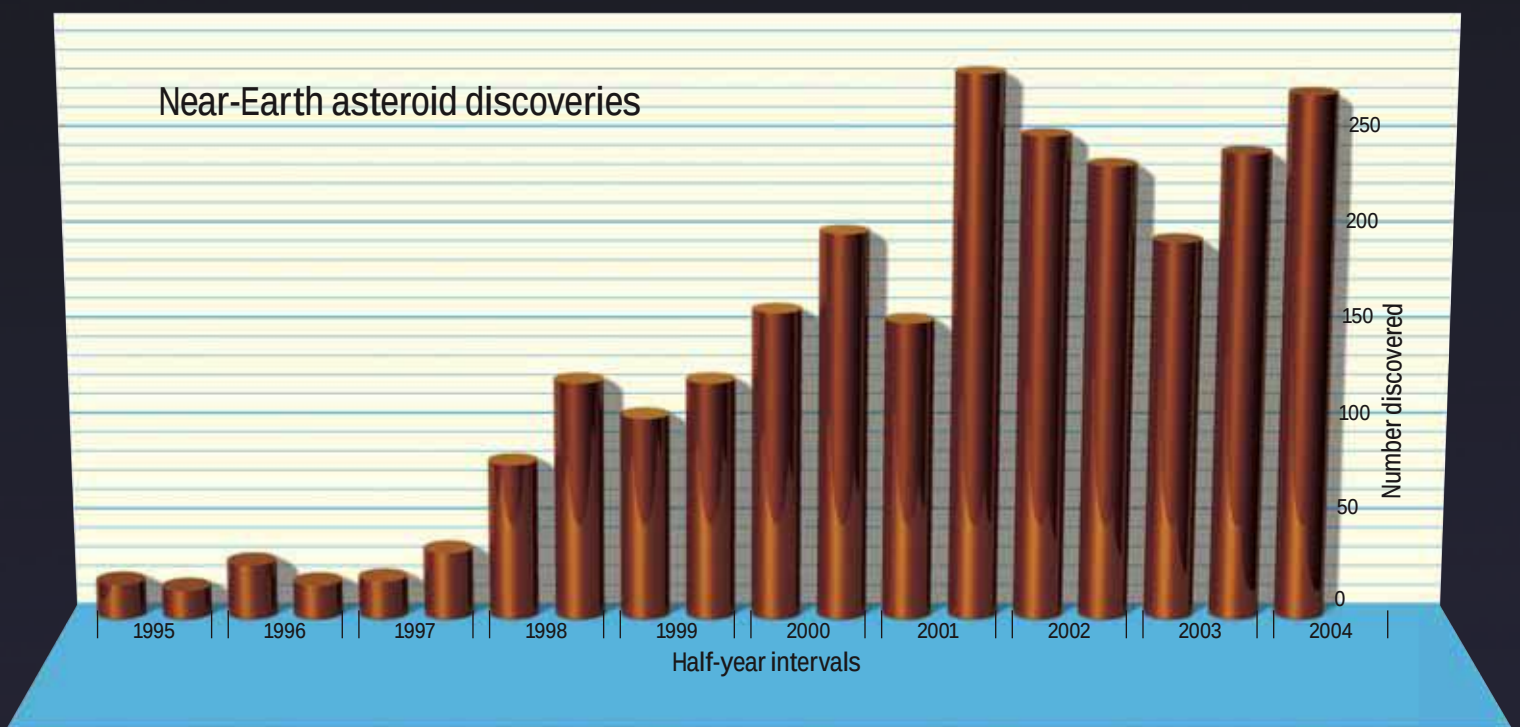
Observational evidence supporting computer simulations comes from satellites operated by the U.S. Departments of Defense and Energy. While the satellites are designed to look for tests of nuclear weapons and missile launches, their visible and infrared sensors can detect, measure, and track the momentary flashes produced by small asteroids fragmenting in the upper atmosphere. Recently declassified data show that from January 1994 to September 2002, these sensors detected some 300 fragmentation events, with energies ranging from 0.1 to 20 kilotons. The events occurred all over the world.

> No government agency, especially NASA, is responsible for issuing a warning of an impending asteroid strike.

Warning network

The asteroid threat is the one natural disaster humans can prevent. Let's see how we can minimize the risk from NEOs bigger than a football field.

Even harsh critics of asteroid defense will admit that, if a real threat emerged, we could develop a program capable of deflecting an asteroid in



HOW ARE WE DOING? Not too bad. This diagram shows the number of near-Earth asteroids discovered in 6-month periods. The LINEAR search dominates the discovery statistics. *ASTRONOMY:* ROEN KELLY

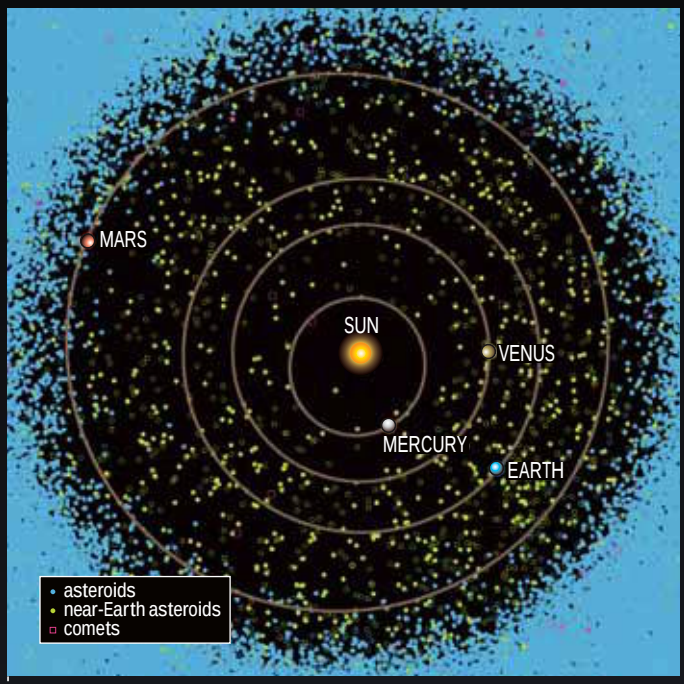
10 to 15 years' time. In the here and now, however, we must treat the NEO threat much as we deal with that posed by hurricanes and tornadoes. This means we must be able to discover and track hazardous asteroids and, if they are going to strike, predict when and where the impact will occur.

Meteorologists use satellites and radar to track hurricanes and tornadoes. Astronomers use telescopes to locate and determine the orbits of asteroids, and it's more difficult than you might think. Consider, for example, the fact that NEOs are dark, not bright objects like planets. A former professor of mine described the search for NEOs as trying to find a mile-wide rock the color of pencil lead from millions of miles away. This difficult task requires meter-size or larger telescopes with modern CCD detectors.

Such telescopes exist and form the nucleus of the Spaceguard Survey, an international effort to find 90 percent of all potentially hazardous asteroids larger than 1 kilometer across by the end of 2008. The reigning champion search team is the Lincoln Near-Earth Asteroid Research (LINEAR) program located at Stallion Site at the north end of White Sands Missile Range in New Mexico. Consisting of two 1-meter, highly automated telescopes formerly used to track satellites, plus CCD technology developed for the Strategic Defense Initiative, LINEAR photographs large areas of sky each night. In operation since 1998, it has discovered the great majority of known NEOs.

However, just finding an asteroid is not enough; its orbit must be accurately determined before its chance of hitting Earth can be calculated. Discovery observations from LINEAR and other search telescopes are transmitted to the Minor Planet Center, located at the Harvard-Smithsonian Center for Astrophysics in Cambridge, Massachusetts. The astronomers there calculate a preliminary orbit and position predictions for each object and post these on a web site. Asteroid observers, many of them advanced amateur astronomers, search the appropriate areas of sky and report measurements of the asteroid's position. Such follow-up observations, carried out while the asteroid is visible, help refine the orbit.

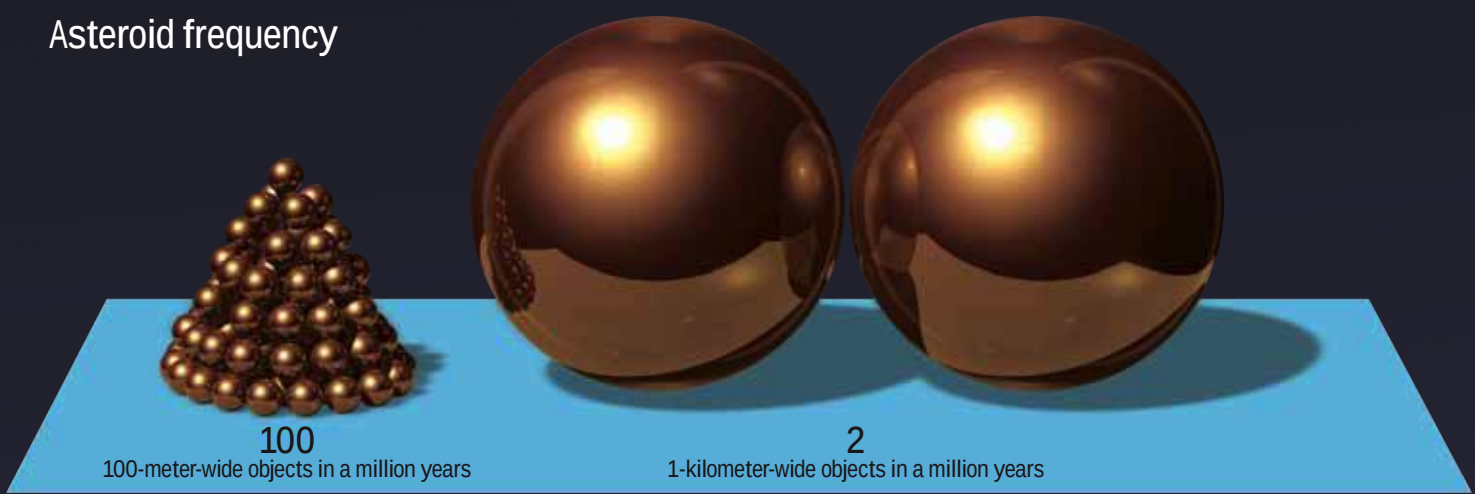
In fact, this is an area where amateur astronomers make significant contributions, as modern technology brings all but the faintest NEOs within reach of their equipment. Amateurs can discover NEOs and help determine their orbits, rotation periods, and colors. For example, amateur astronomer Brian Warner made the observations that definitively established asteroid 2004 AS1 was not going to strike Earth in mid-January 2004.



WE'RE SURROUNDED. Blue dots plot the locations of known asteroids in mid-August 2004. Yellow dots indicate near-Earth asteroids, while comets are shown in red. IAU MINOR PLANET CENTER

As of the end of 2003, the Spaceguard Survey had discovered more than 700 near-Earth asteroids bigger than 1 kilometer. The best estimate puts the total number of such objects at about 1,000, give or take 100. This means the search is about 70-percent complete. If the present rate of discovery continues, by late 2008 or early 2009, we should achieve the survey's goal of 90 percent — on schedule and within budget. Once the survey is complete, we should know if any large asteroid capable of causing global damage and mass extinction will strike Earth within the next few hundred years. That's a comforting thought, especially when you consider we will probably have decades,

Asteroid frequency



SMALL ASTEROIDS HIT MORE OFTEN, while large ones are rare. During a span of 1 million years, we can expect two impacts from 1-kilometer-wide NEOs — but 100-meter, "city-killer" asteroids will hit us 50 times more often. *ASTRONOMY:* ROEN KELLY

SATELLITE SENSORS detect the heat of exploding NEOs. This plot shows the worldwide distribution of atmospheric impacts for the past three decades, from late 1972 to mid-2001. Red circles show where blasts occurred during daylight, while blue indicates explosions ocurring at night. On average, meteoroid breakups create at least one 5-kiloton explosion each year. ET SPACE SYSTEMS/P. BROWN, UWO

perhaps even centuries, to handle any asteroid with a significant chance of hitting us.

But what of the much more numerous asteroids with sizes below 1 kilometer and above the 100-meter protection offered by the atmosphere? These will be the main focus of the next survey, consisting of telescopes like the Panoramic Survey Telescope and Rapid Response System (Pan-STARRS), being built by the University of Hawaii, and the proposed Large-aperture Synoptic Survey Telescope (LSST). Instruments like these will extend our detection limit down to 150-meter NEOs, close to the size where we can leave them to be dealt with by the atmosphere. The prospect of finding and keeping track of better than 90 percent of the entire threatening NEO population is no illusion; it appears achievable within the next 15 years. This is very good news, and I urge everyone to voice support for LSST and scopes like it. At some point down the road, someone's safety, perhaps your children's or grandchildren's, will depend upon them.

Duck and cover?

Should surveys detect an NEO on an impact course, the logical next move would be to evacuate the impact area, as with hurricanes or tornadoes. One advantage with an asteroid warning over hurricane or tornado warnings is that celestial mechanics is much less chaotic than the weather, permitting a precise prediction of ground zero. The disadvantage is that the affected area is likely to be quite big — on the scale of a large metropolitan area. Imagine having to evacuate New York City or Los Angeles.

Until very recently, the NEO search community gave little thought to how it would alert the proper authorities of an impending asteroid strike. Then, on the evening of January 13, 2004, a single rock came along and changed things. Over a span of hours, it looked like 2004 AS1 had about a 25-percent chance of striking Earth within the next day and a half. For the first time, asteroid researchers found themselves discussing whether a warning should be given, and if so, to whom and what it would say.

The observations by Brian Warner mentioned above soon eliminated the possibility of impact — indeed, further observations showed that the asteroid missed us by a comfortable 7.5 million miles (12 million kilometers). But the incident had an effect. It spurred NEO researchers into creating a way to pass along an impact warning to the government, which hopefully would take action.

I wish to be very clear at this point. *No government agency, especially NASA, has the responsibility of issuing a warning of an impending asteroid strike*. Nor would any agency want it — imagine the consequences that would result if a major city were evacuated and no impact occurred. Equally bad would be if no warning were given of an actual hit. (The latter is more likely because the Spaceguard Survey detects only a small fraction of 100-meter-size asteroids — city-killers.) At present, the way any warning would be passed along is informal and unofficial. Donald Yeomans, head of the NASA NEO Program Office, would brief Lindley Johnson, who heads the NEO observations and planetary astronomy programs at NASA Headquarters, about any potential impactor. Johnson would then determine the necessity of warning other government officials. It's simple and informal, but at least it's a start.

What about long-period comets? There are several reasons for ignoring their threat, number one being that comets account for a very small fraction of the total impact risk, about 1 percent. Reason two is that comets warm up as they enter the inner solar system, and their orbits change constantly as they shed material. With asteroids, you can tell if one is going to hit decades or centuries in advance; with comets, you're lucky if you can achieve a few weeks notice. Reason three is that comets are big — usually several miles across. If one were about to strike us, there is very little we could do . . . except dig a hole and wait for the decades of darkness and cold to pass. A

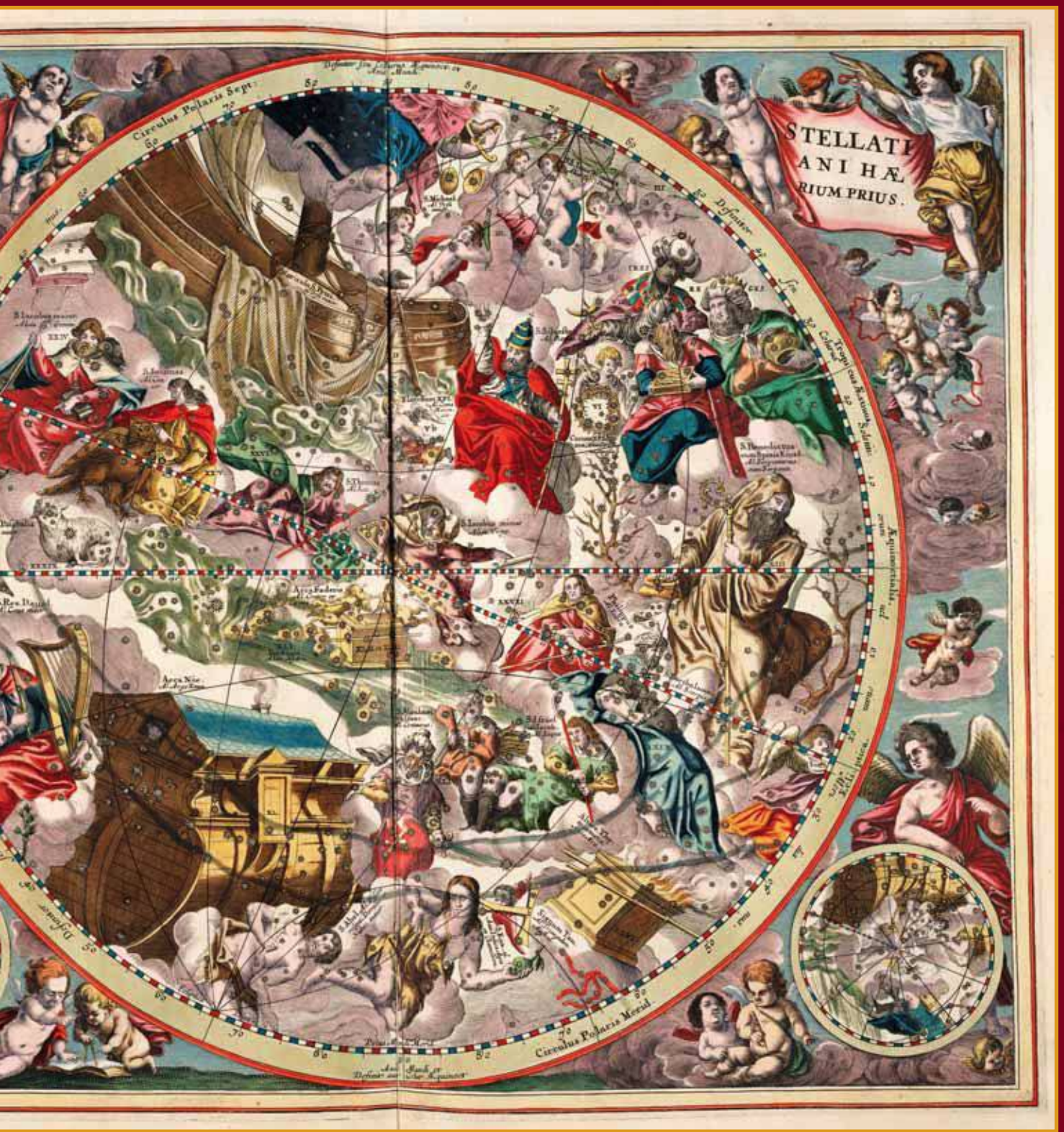
For more about who's searching for a wayward rock with our name on it, see www.astronomy.com/toc

the golden age of star maps

Today's star atlases display thousands of objects plotted to precision. A time existed, however, when the beauty of the atlas was as important as its accuracy. /// BY WIL TIRION

The years from 1603 to 1801 were the glory days of celestial mapping. During that time, many colorful and useful star maps were created by a variety of equally colorful individuals. Thankfully, most of the works from that period have survived. Five atlases in particular — known as the "grand" atlases — stand head-and-shoulders above the rest. These atlases — Bayer's *Uranometria*, Schiller's *Coelum Stellatum Christianum*, Hevelius's *Uranographia*, Flamsteed's *Atlas Coelestis*, and Bode's *Uranographia* — were lavish productions encompassing both science and art.

A century before the "golden age," Albrecht Dürer (1471–1528) published the first printed star maps in 1515. A simple pair of woodcuts, one map shows the northern and the other the southern celestial hemisphere. The maps display the 48 classical constellations listed by Greek philosopher Claudius Ptolemaeus (Ptolemy) in the second century. If you study these maps, you'll see a large area of the southern sky is still void of constellations. In the 16th century, this part of the sky was as yet unexplored by European astronomers.



COELUM STELLATUM CHRISTIANUM (The Christian starry sky) was published in 1627 by Julius Schiller. The atlas's two hemispheric maps were republished and printed in color in 1661 in the atlas *Harmonica Macrocosmica seu atlas universalis et novus* by Andreas Cellarius. A portion of one of the hemispheres — showing the early evening stars of winter — is seen here. LINDA HALL LIBRARY OF SCIENCE, ENGINEERING, AND TECHNOLOGY

Southern views

Between 1595 and 1597, two Dutchmen, Pieter Dirksz Keyser (d. 1596) and Frederick de Houtman (1540–1627) observed the southern sky on expeditions to the Far East. They created a star catalog containing 200 stars near the South Celestial Pole plus 11 new constellations (Apus, Chamaeleon, Dorado, Grus, Hydrus, Indus, Musca, Pavo, Phoenix, Tucana, and Volans). A twelfth constellation, Triangulum Australe, also was described, but this figure had been mentioned previously in a letter by Italian explorer Americus Vespucci in 1503, so the two explorers didn't receive credit for its invention.

Some believe Keyser and de Houtman invented the constellations. Others say Petrus Plancius (1552–1622), a scientist from Amsterdam, was their creator. Plancius passed Keyser's catalog on to Johannes Bayer (1564–1617), a lawyer in Augsburg, Germany, who used the information to create one of the milestones in stellar cartography, his *Uranometria*, published in 1603.

Bayer's atlas contains 48 star maps, each showing one of Ptolemy's constellations, plus one map showing the twelve new southern constellations. Bayer was the first to use Greek letters to identify stars in a constellation. Since the publication of *Uranometria*, Betelgeuse, the right shoulder of Orion the Hunter, is also known as Alpha (α) Orionis; and Rigel, Orion's left foot, is also known as Beta (β) Orionis.

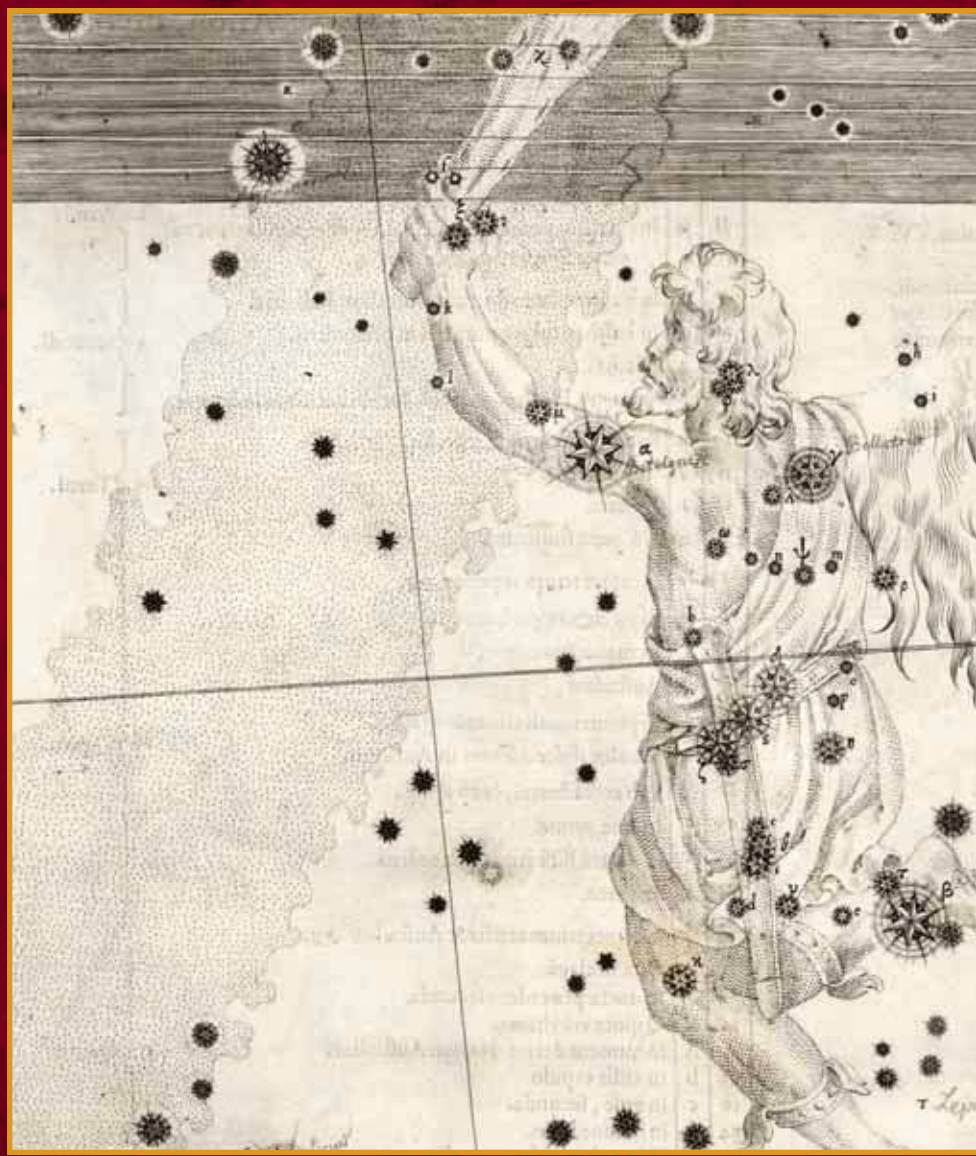
Bayer did not always assign the first letter of the Greek alphabet (α) to the brightest star. Many examples demonstrate that Bayer used different criteria in deciding the letter sequence. An interesting example is Sagittarius, where the letters α and β are assigned to Rukbat and Arkab, both 4th-magnitude stars in the most southern part of the constellation. In spite of all arguments about this, it is interesting to see that on Bayer's map of Sagittarius, these two rather faint stars are shown as being the brightest stars in the constellation.

Occasionally, Bayer's lettering scheme was positional. An example lies within the constellation Ursa Major the Great Bear. Bayer gave the stars of the Big Dipper — from the tip of the bowl to the end of the handle — the first seven Greek letters in order. This certainly does not reflect the true brightnesses of these stars.

Celestial testament

An interesting atlas was published in 1627 by Julius Schiller (d. 1627), another lawyer from Augsburg: *Coelum Stellatum Christianum* (The Christian starry sky). All the mythological heroes are removed, together with almost all the other classical figures. In their places, Schiller invented new constellations from the Bible and Christian tradition. The twelve constellations of the zodiac became the twelve apostles. The sky north of the ecliptic was dedicated to the New Testament, while south of the ecliptic, only figures from the Old Testament are shown. Schiller included the large constellation Argo Navis the Ship Argo (now divided into Puppis the Stern, Carina the Keel, and Vela the Sails), which was renamed a few decades earlier by Plancius, who called it Arca Noë (Noah's Ark). Plancius also created a new constellation close to it, Columba the Dove (Noah's Dove).

Although most of Schiller's figures are no longer used, Columba has survived to the present day. Schiller created his beautiful atlas in cooperation with several other people, including Johannes Bayer. Bayer did the astronomical part of the work, which mainly consisted of positioning the stars correctly, and Schiller concentrated on drawing the constellation figures. The result was a newer and more accurate version of the *Uranometria*. *Coelum Stellatum Christianum* consists of 49 maps portraying the constellations, plus two circular hemispheric maps. The atlas became very popular in its time, as shown by the fact that the two hemispheric maps were republished in the 1661 atlas *Harmonica Macrocosmica seu atlas universalis et novus* by Andreas Cellarius (1596–1665).

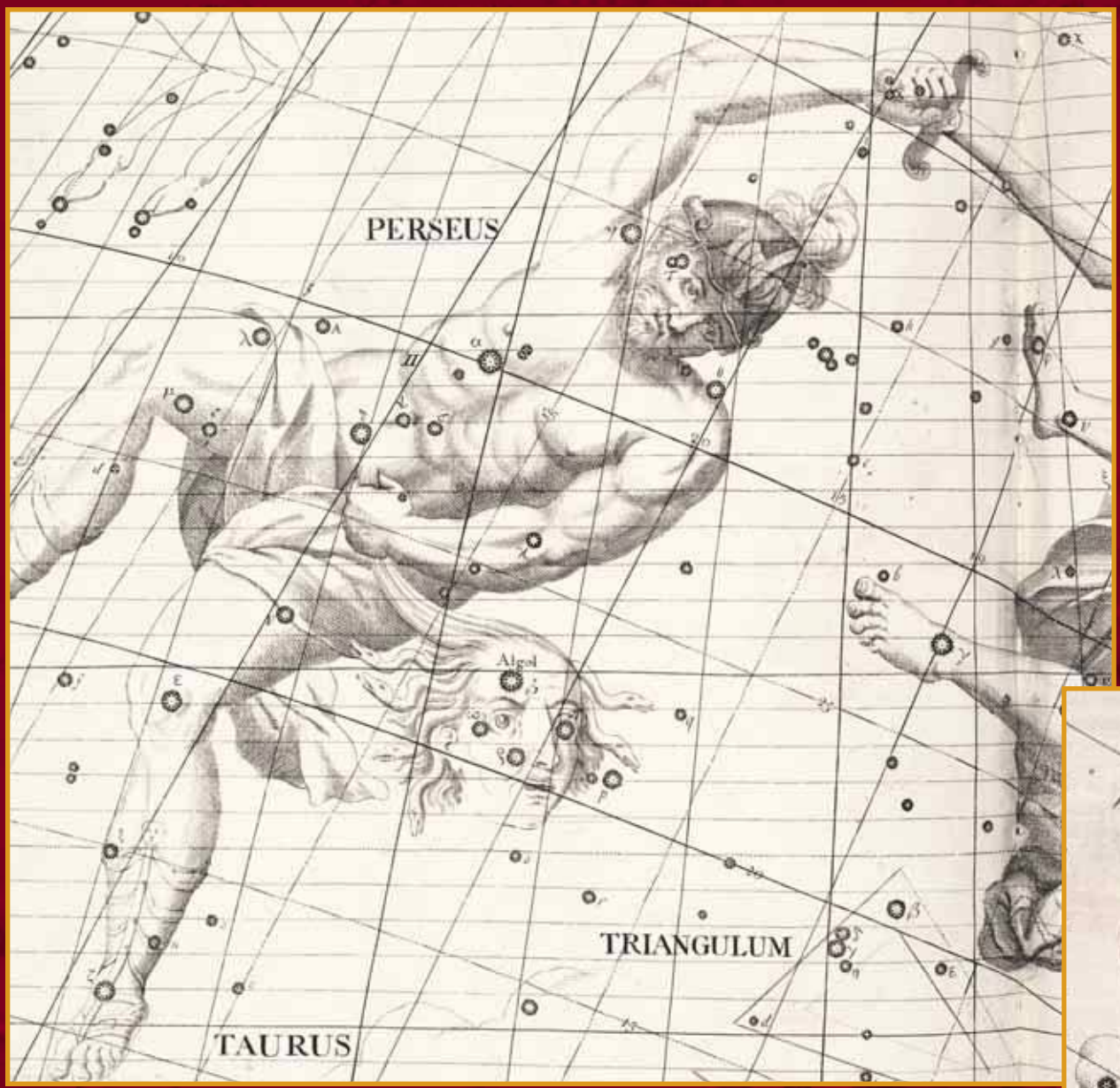


ORION THE HUNTER was illustrated in the first of the grand atlases, Johannes Bayer's *Uranometria*, published in 1603. If you look closely, you'll see tiny Greek letters next to some of the stars. Bayer introduced the practice of labeling bright stars with Greek letters in this atlas. LINDA HALL LIBRARY OF SCIENCE, ENGINEERING, AND TECHNOLOGY

Wil Tirion *is a world-renowned uranographer (maker of celestial maps).*

AURIGA THE CHARIOTEER is shown in an unusual way on Johannes Hevelius's atlas *Firmamentum Sobiescianum sive Uranographia*, printed in 1690. Because the atlas was drawn mirror-reversed (as if the observer were on the outside looking in), the three goats Auriga usually holds to his breast are shown at his back. LINDA HALL LIBRARY OF SCIENCE, ENGINEERING, AND TECHNOLOGY

THE ARCHANGEL GABRIEL was formed from the stars of Pegasus the Winged Horse in Julius Schiller's *Coelum Stellatum Christianum*. LINDA HALL LIBRARY OF SCIENCE, ENGINEERING, AND TECHNOLOGY



PERSEUS THE HERO is shown here immediately after slaying the Gorgon Medusa. This illustration is from John Flamsteed's *Atlas Coelestis*, which was published in 1729. Note the criss-crossing lines of Right Ascension and Declination. *Atlas Coelestis* was one of the first star atlases to employ equatorial coordinates. LINDA HALL LIBRARY OF SCIENCE, ENGINEERING, AND TECHNOLOGY

THE CONSTELLATION CRUX became important as a navigational tool to early sailors in the Southern Hemisphere. This image is from Johann Elert Bode's *Uranographia*, printed in 1801. LINDA HALL LIBRARY OF SCIENCE, ENGINEERING, AND TECHNOLOGY

Backward sky

The next major atlas to be published was *Firmamentum Sobiescianum sive Uranographia* by Johannes Hevelius (1611–1687). Published in 1690, it is a beautiful work, and its artistic level equals that of Schiller's atlas. There is one peculiar thing about *Uranographia*, however. Like many other atlases of the time, its maps show the sky mirror-reversed, a strange phenomenon that originated with celestial globes. On a globe of Earth, we see Earth with the continents and oceans at the outside.

But the sky can be regarded as a huge, imaginary sphere. As observers, we look at the inside of that sphere, while a celestial globe is viewed from the outside. So on a celestial globe, the constellations are shown as they would appear from the outside of the imaginary sphere — in other words, mirror-reversed. Without at least this minimum level of logic, a mirror-reversed sky also was shown on many flat star maps, like the ones in *Uranographia*. A mirror-reversed sky had some strange consequences. Many stars still were referred to by the descriptions in Ptolemy's catalog. Stars were described as "the star in the right knee of Andromeda" or "the star in the left shoulder of Orion," but on a mirror-reversed map, left becomes right and vice-versa. To avoid confusion about left and right, many of the figures were turned around, so on these maps, instead of looking at the fronts of the constellations, you look at their backs. Looking at Auriga the Charioteer in Hevelius's atlas, we see something remarkable. Auriga holds three goats to his breast, but because the Charioteer was turned around, the goats had to move to his back, to prevent them from becoming invisible.

British stars

The next landmark celestial atlas is John Flamsteed's *Atlas Coelestis*, published posthumously in 1729. Flamsteed (1646–1719) was the first Astronomer Royal of England. *Atlas Coelestis* is one of the first atlases that used equatorial coordinates. Older atlases mainly used ecliptic coordinates. In *Atlas Coelestis*, the ecliptic grid also is shown running at an angle to the equatorial grid. The name Flamsteed is well known today because of Flamsteed numbers, an alternate way to identify the brighter stars of a constellation. The numbers begin at the western edge of each constellation and proceed in order of Right Ascension.

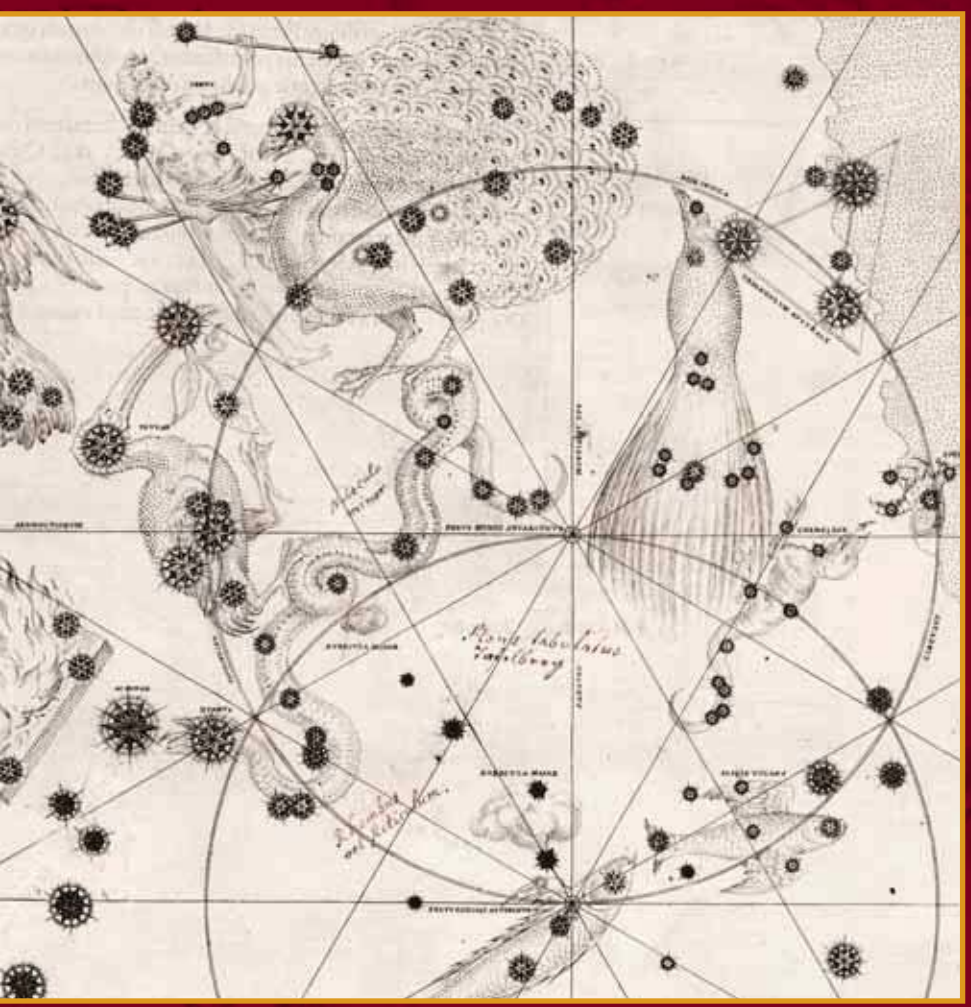
Many stars are referred to today by their Flamsteed number (like 61 Cygni). Some have both a Greek letter (assigned by Bayer) and a Flamsteed number. But here we have a misconception. Flamsteed's maps contain only Greek letters — no so-called Flamsteed numbers. The numbers actually originated in a French edition of the atlas and the accompanying catalog. The editor, Joseph Jerome de Lalande (1732–1807), assigned numbers to the stars in the catalog. So it was not Flamsteed who introduced the Flamsteed numbers, but Lalande.

Last, but not least

The final grand atlas is from another German astronomer, Johann Elert Bode (1747–1826). His *Uranographia*, published in 1801, was actually his second atlas. In 1782, he published an atlas with the title *Vorstellung der Gestirne* (Presentation of the stars), which was a simplified version of Flamsteed's atlas.

The new feature of the atlas was the introduction of constellation boundaries, which also were shown in his *Uranographia*. *Uranographia* set new limits for star atlases. For the first time, stars not visible to the naked eye were displayed, and Bode used chart projections that were far superior to everything done before. Bode used conical projections, and the atlas showed the stars and constellations less distorted than they had been in previous atlases. Bode's *Uranographia* was an important step toward the modern star atlases we enjoy today.

Today's star atlases are not nearly as beautiful as those created hundreds of years ago, but they do have the advantage of accuracy. When the grand star atlases were made, the artistic figures themselves defined the constellations. Today, each of the 88 constellations has a strictly defined boundary. The grand atlases may be fun to look at, but today's astronomers are glad — at least in this instance — that science has prevailed over art.



TWELVE SOUTHERN CONSTELLATIONS made their first appearance in a star atlas when Bayer included this map in *Uranometria*. These constellations — Apus, Chamaeleon, Dorado, Grus, Hydrus, Indus, Musca, Pavo, Phoenix, Triangulum Australe, Tucana, and Volans — were formed from stars plotted by Keyser and de Houtman. LINDA HALL LIBRARY OF SCIENCE, ENGINEERING, AND TECHNOLOGY

See more antique star maps at www.astronomy.com/toc

Astrology: FACT or FICTION?

If you even *glance* at your daily horoscope, it's time to discover the facts about astrology. /// BY MICHAEL E. BAKICH

"You study astrology, don't you?"

I've gotten used to that question. Many people confuse astronomy — the science that studies celestial objects — and astrology — a belief that those same objects in the cosmos influence individual lives here on Earth. Most people know astronomy deals with facts and figures, but what about astrology? What are its facts? Where did it originate? And, most importantly, does it work?

At night, thousands of stars shine overhead. How can we ever get to know all the stars, tell one from another, or even understand their effect on our lives?

People first tried to answer these questions 6,000 years ago in the "Cradle of Civilization" — Mesopotamia. In southern Babylonia, a tribe known as the Chaldeans looked to the stars for guidance and counted their months by the phases of the Moon. When the crescent Moon appeared in the western evening sky, it signaled the beginning of a new lunar month of 29 or 30 days. In those ancient times, the first crescent Moon of summer was seen among the stars of Leo the Lion. The Chaldeans noticed the Moon appeared farther east each evening, waxing full in a different constellation each month. It passed through Virgo the Virgin, through Libra the Scales, and on through the same constellations year after year. Thousands of years later, the Greeks called the constellations the "circle of animals," or *zodiakos kyklos* — the zodiac.

The lunar calendar, clever as it was, left the Chaldeans with a sticky problem: It gave them only 354 days in a year — about 11 days short. The purpose of their calendar was to predict the coming of seasons. They needed to know when to sow, when to reap, and when they could expect rain. But with an error of 11 days per year, their calendar would be 6 months out-of-sync with the seasons in less than 20 years. Obviously, more research was needed to complete their 365-day calendar, so the Chaldeans turned to the planets for their solution.

They called the planets *bibbu*, or wild goats, for the way they seemed to prance and run among the slower-moving stars. The planets visible to them — Mercury, Venus, Mars, Jupiter, and Saturn — like the Moon, traveled through the zodiac. For the Chaldeans, the zodiac took on greater significance.

The Chaldeans made a major discovery while monitoring the night sky from dusk to dawn. As the morning sky brightened, they noted the lowest zodiacal constellation visible in the east. As an example, let's say it was Sagittarius. They reasoned correctly that the Sun must lie in the next constellation — Capricornus. Because the rising constellation changed during the year, the Sun must make the same journey through the zodiac as the Moon and planets.

The Chaldeans chose 12 constellations of special importance in the nighttime sky — one for each Full Moon of the year. And they defined the zodiacal path, along which the Sun, Moon, and planets travel. While searching for a more accurate calendar, they created the foundation of astrology.

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Gods and magic

For a thousand years, the Babylonian priesthood collected detailed observations of the heavens, but the true nature of the stars and planets eluded them. Eventually, each planet became identified with a god or goddess. With only slight changes, they would later be adopted into the mythology of the Greeks and Romans.

The Greeks who lived around 300 B.C. were the first to formalize the influences of the planets and constellations on human affairs. Most of the influences were drawn from a combination of earlier Babylonian mythology and their own. For example, because Mars was the god of war, the significance of the planet Mars concerns war, blood, and fire. It's usually a bad sign. Because Venus was the goddess of love, the planet's influence pertains to pleasure, children, luck, and wealth, making it a good sign.

The Greeks also applied the theory of magical correspondence to astrology. Because a constellation is called "the Bull," its influence on people is to make them bullish — that is, they are rather stubborn, opinionated, and unintelligent.

Astrology, then, became an odd combination of three separate disciplines: science — the observable motions of the Sun, Moon, and planets; religion — the deities of both Greek and Roman mythology; and magic — the supernatural principle of correspondence between a constellation and its influence on people.

Due to the growing popularity of scientific thought, many modern astrologers refer to their craft as the "science" of astrology. And, as we have seen, it does have a scientific element — its astronomical side. Even if we ignore astrology's religious and magical components, how scientifically valid is it? We can begin by examining the astrological signs.

What's your sign?

The most frequently asked question in astrology must be "What's your sign?" Specifically, this means: "In which sign of the zodiac was the Sun on the date of your birth?" The answer is not as simple as it may appear.

Astrologers divide the zodiac into 12 equal parts called "signs." Each sign represents a space in the zodiac ruled by one of the 12 constellations. According to astrologers, the Sun is "in" each sign for about 30 days.

This system gives us the horoscope table most familiar to the public — the one you find in newspapers or magazines. According to this table, a person born November 10 is born under the sign of Scorpius the Scorpion. But when we look at the night sky November 10, the Sun is not in the constellation Scorpius — it's in Libra the Scales.

Which characteristics then should we expect in this person, those of the Scorpion, or those of the Scales? All the signs of the zodiac have the same problem: Every constellation occupies the space in the zodiac assigned to the previous constellation.

Michael E. Bakich *is an associate editor of* Astronomy.

It wasn't always this way. Approximately 2,200 years ago — when the birth dates corresponding to each Sun sign were determined — the signs corresponded to the constellations. Since then, however, the constellations have shifted almost 25°.

A peculiar motion of Earth called "precession" is responsible for this shift. Because of gravitational influences from the Sun and Moon, Earth's axis wobbles like that of a slowing top. Earth completes one precessional cycle — or one complete wobble — every 26,000 years.

Since the days of ancient Greece, precession has carried all the zodiacal signs nearly one constellation to the west. The precessional shift will continue, and the error will increase every year until 24,000 years from now, when the signs will match the constellations they are named for once again.

If you ask modern astrologers about precession, they probably will tell you it doesn't matter — it's the signs that are important, not the constellations. But, without the constellations, where do the signs get their magical powers? Without Scorpius the Scorpion, what's scorpion-like about the sign Scorpio? What's bullish about the sign Taurus without the constellation of Taurus the Bull? How can we believe in influences from the stars even if astrologers say the stars are irrelevant? Although astrologers generally ignore the effects of precession, they do not deny its existence. In fact, they've been known to exploit it:

> *When the Moon is in the 7th house*
> *And Jupiter aligns with Mars*
> *Then peace will guide the planets*
> *And love will steer the stars.*
> *This is the dawning of the Age of Aquarius*
>
> — The Fifth Dimension (1969)

Under a modern system of astrology, would people born under the sign of the Teapot be short and stout, and frequently blow off steam?

The Age of Aquarius

The rock musical *Hair* that opened in 1969 became the first Broadway production knowingly to list astrologers in the credits. Its hit song, "The Age of Aquarius," became one of the few optimistic notes in a decade plagued by war and civil unrest. The song promised a dramatic change from turmoil to peace, love, and prosperity as we left the Age of Pisces and entered the Age of Aquarius.

We are approaching the Age of Aquarius, but not because "the Moon is in the 7th house" or because Jupiter is aligning with Mars — both of which are common occurrences. We're entering the Age of Aquarius because of precession. Astrology recognizes 12 "great ages." Each great age begins when precession moves the Sun, viewed on the first day of spring, into a new sign.

If we imagine Earth's equator, projected into space, it becomes the "celestial equator." The first day of spring (or autumn in the Southern Hemisphere) officially occurs when the Sun, traveling northward along its apparent path (the ecliptic), crosses the celestial equator. That moment is called the "vernal equinox." Two thousand years ago, the vernal equinox was in the sign of Aries the Ram. It was the Age of Aries.

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Due to precession, the vernal equinox moves westward through the stars slowly. Today it's in Pisces the Fishes, and this is the Age of Pisces. By now, you've probably guessed the constellation west of Pisces (Aquarius). Because the vernal equinox is moving gradually toward a rendezvous with Aquarius, it can be said we are at the "dawning of the Age of Aquarius." But don't look for worldwide peace and understanding too soon — this momentous event is still nearly 600 years away.

More problems

Even if we ignore the wrench slipped into the astrological works by precession, we still have a number of dilemmas. If we divide the circle of the zodiac (360°) into 12 equal signs as astrologers do, each sign would be 30° wide. Astrologers assign between 29 and 32 days for the time the Sun spends in each sign. This is a major deviation from what we actually see in the sky.

The Sun's apparent path through each zodiacal constellation is hardly 30°. The amount of time the Sun spends in each constellation ranges from 7 days for Scorpius to 45 days for Virgo.

Compare the table of "horoscope" birth dates to the table for each constellation as it appears in the sky. The odds are greater than 7-to-1 that on your birthday, the Sun was not in what you thought was your constellation.

Each year, from December 1 to 17, the Sun is in front of the stars of the constellation Ophiuchus the Serpent Bearer, which lies in the circle of the zodiac. Ophiuchus is found between Scorpius and Sagittarius. Oddly enough, the Sun spends 17 days a year in Ophiuchus compared to 7 days in Scorpius. But traditional astrology ignores whatever influences Ophiuchus may have on our lives.

The Sun appears in 13 constellations, but the Moon may appear in five additional constellations and the visible planets in six more. That's 24 constellations — if we ignore the motions of Pluto. Pluto has a highly-inclined orbit. It may appear in 17 additional constellations, bringing the total to 41.

Astrologers attribute profound influences to the three outer planets — Uranus, Neptune, and Pluto. Uranus was discovered in 1781, Neptune in 1846, and Pluto in 1930. The ancients had no telescopes and, therefore, no knowledge of these planets. In fact, in 1610, Italian religious fanatic Sizzi wrote this about the Sun, the Moon, and the five visible planets:

Just as there are seven openings in the head, there are seven objects which move through the heavens. We need no more, therefore, there are no more!

> The more we know about astronomy, the more we question astrology.

Today's astrology texts describe in detail the effects of the outer planets on humans. But how have modern astrologers determined the exact influences of Neptune and Pluto? From the time of their discovery, neither one has made a complete revolution around the Sun! It seems the more we know about astronomy, the more we question astrology.

Cosmic influences

When preparing horoscopes, astrologers rely on astronomical observations and scientific theory to compute the positions of the planets. Because science is used in the first stage of the process, it's logical to wonder if it is used in computing, or inventing, the astrological influences. After all, the final step for astrologers is to determine the effect of these influences on an individual's life and predict an individual's fortune.

/// ASTROLOGERS' LIBERTIES

Venture to a professional astrologer, and you'll find the Sun sign is only one facet of modern astrology. Because the Sun signs limit the astrologer to 12 basic personality types, most astrologers today emphasize the "sidereal horoscope." Here's how it works:

On your birth date, one of the zodiacal signs rose on the eastern horizon. This sign is your "ascendant." Remember: We are referring to the zodiacal signs established more than 2,000 years ago.

When reading your horoscope, an astrologer begins with the date, time, and place of your birth, and a chart divided into 12 segments or "houses." The astrologer completes the chart using symbols for each sign of the zodiac.

Outside the first house, the astrologer writes the symbol for the ascendant — let's pick Leo the Lion as an example. The astrologer then adds symbols for the remaining signs in their proper sequence, as they would rise over the horizon.

The Sun, Moon, and planets also have symbols. The Sun on this birthday was in the sign of Sagittarius, which put it in the fifth house. The Moon was in the sign for Pisces, so it was in the eighth house. The symbols for all the planets are entered according to the zodiacal sign they occupied on this birth date.

The astrologer then compares the positions of the planets to one another. An angle of 180° is an "opposition" — a tug-of-war between planets. That's bad, portending disaster. An angle of 120° is a "trine." That's very good. An angle of 90° is a "square." It's bad, but not as bad as an opposition. An angle of 60° is a "sextile." It's also good.

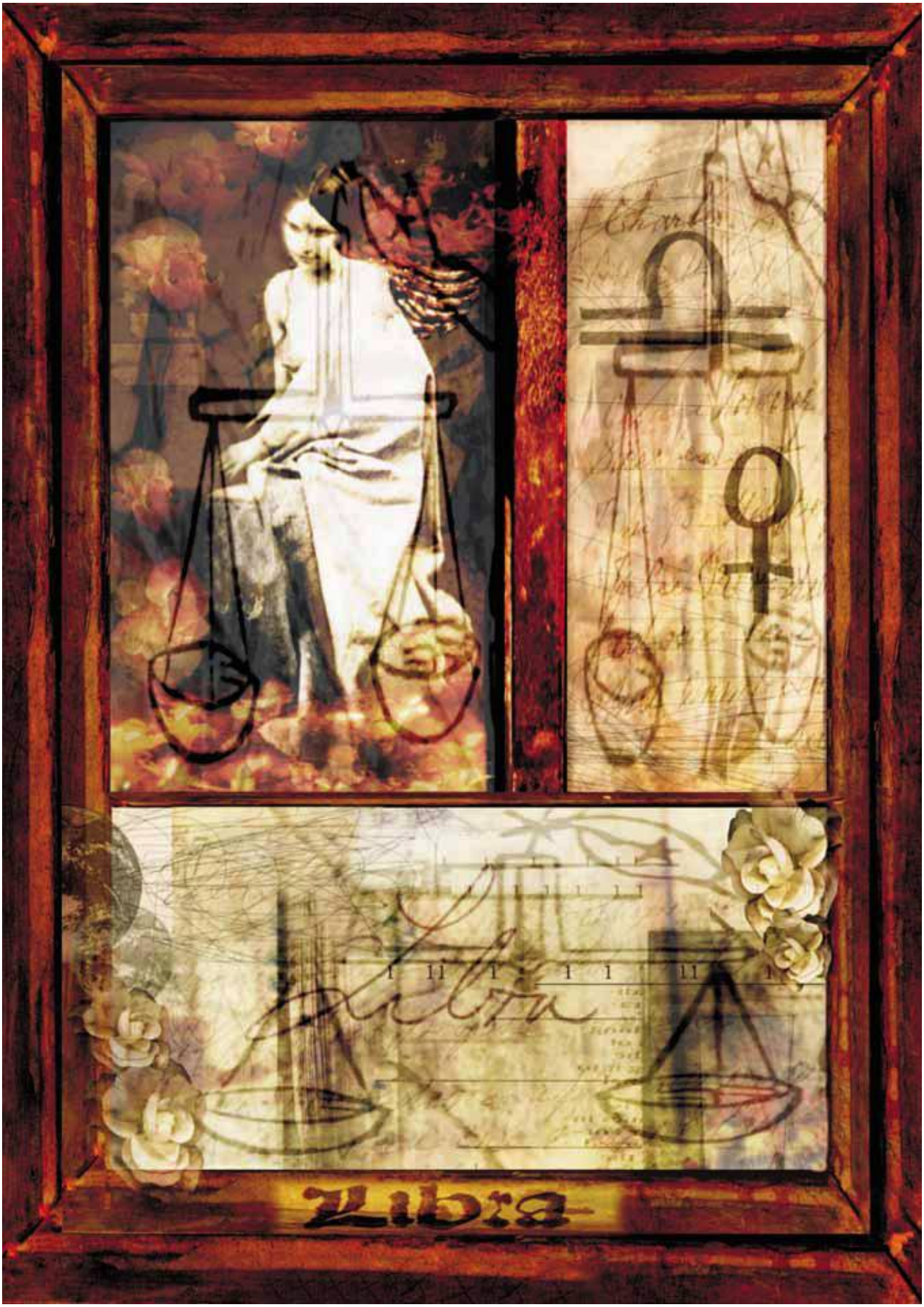
All of these angles are plus or minus 7°. An opposition can be anywhere from 173° to 187°, a trine, between 113° and 127°, and so on. Astrologers give no reason for allowing this margin of error.

If the Sun and Moon are within 10° of each other, or if two planets are no more than 12° apart, that's a "conjunction." It can be either good or bad depending on the planets involved.

Each house is said to control one aspect of your life. Your first house and the planets it contains determine your natural tendencies and appearance. Your second house controls your money and possessions. And so on, from your home and children, to your honor and death.

At this point, you may have several questions for your astrologer. Why is a trine good and a square bad? And why is the moment of birth the most important? Isn't the moment of conception when all the physical traits are passed along to a child?

If you'd like solid answers, you're out of luck. There aren't any!



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Twenty-two centuries ago, scientific theory was in its infancy. The Greeks believed Earth was at rest in the center of the universe. They had no knowledge of the distances to the planets, no knowledge of their orbits around the Sun, and no theory of gravity to compute their motions accurately. However, they did notice correspondences between heaven and Earth. For example, the seasons on Earth progress through cycles that follow the changing position of sunrise. The Greeks also noted a correspondence between the phases of the Moon and the rise and fall of ocean tides. With such obvious examples as guides, it was easy to believe in the existence of cosmic influences — 2,200 years ago.

Today, we are indebted to the intuition of the ancients. Not only do we believe in cosmic influences, but we've been able to identify, describe, and measure them. Modern science recognizes the force of gravity along with electromagnetic and nuclear forces. In addition, there are various forms of radiation — light, radio, and X rays to name a few. Are any of these the "magical influences" ascribed to the planets and stars?

Consider a baby at the moment of birth, the critical time in the production of a horoscope. Modern scientific theory enables us to compute not only the positions of the planets in the sky, but the intensity of all known forces and radiation absorbed by a child at birth. The results are worth investigating.

The walls of the hospital block most of the radiation from the Sun and stars. Even if they didn't, the lights in the delivery room far outshine any stellar radiation. In addition, the building exerts about 10 times more gravitational pull than all eight planets combined — 500,000 times more than the nearest star beyond the Sun. Thus the forces and radiation from space that fall on us at birth are overwhelmed by counterparts within our own environment.

Constellations

But even if we've been interpreting the influences from the planets and stars incorrectly for the last 22 centuries, couldn't a system of astrology be developed based on scientific principles instead of on magic and myth? Before we devote our lives to this endeavor, let's take a closer look at the constellations.

No one, true way to name the constellations exists. They can be whatever our imaginations come up with. We name constellations to map the skies and jog our memories about earthly occurrences.

Capricornus, for example, was given the form of a mountain goat because, 4,000 years ago, this constellation was climbing high into the sky as the Sun was reaching its greatest height. It was also the start of the rainy season, so the Chaldeans added a fish's tail, and Capricornus became that mythical beast, the Sea-Goat.

When modern humans named the constellations, imagination seemed to wane. Much of the constellation Ursa Major the Great Bear is known more commonly as the Big Dipper. And Sagittarius the Archer is reduced to a common teapot. Under a modern system of astrology, would people born under the sign of the Teapot be short, stout, and frequently blow off steam?

Another major point to keep in mind about the constellations is this: Just because two stars are in the same constellation doesn't mean they're physically related. It means only that they're in the same direction. We are left, then, with a sky full of stars grouped only by optical illusion, with each apparent group named according to the mythology and imagination of the viewer. Even an updated system of astrology is off to a shaky start.

Astrology's popularity

Never have the principles of science and rational thinking been more clearly understood than today, and yet 84 million Americans believe in astrology. Five reasons contribute to its popularity.

1. From a psychological standpoint, astrology has a strong appeal. It deals with the self and things of a personal nature, making it an ideal pastime for the "Me Generation."

2. Astrology provides a way out for those who hate to make decisions. For many people who find astrology useful, it gives proof to the adage that any decision is better than no decision at all.

3. Those who practice astrology often feel in possession of secret, esoteric knowledge. They manipulate mysterious symbols and terms; they refer to imposing astronomical tables; and they feel in touch with arcane forces unknown to science. As with black magic and the occult, astrology fills a religious need for some followers.

...the building exerts about 10 times more gravitational pull than all eight planets combined – 500,000 times more than the nearest star beyond the Sun.

4. Astrology is available to answer the perplexing questions of everyday life. How else can John know in advance if Mary will make a good wife, if a particular business venture will succeed, or if a certain plot of land should be purchased?

5. The strongest reason for astrology's persistence is money. Successful astrologers command six-figure incomes. Books on astrology overflow the shelves. Jewelry items celebrate the beauty and mystique of the zodiac. Astrological predictions are guaranteed eye-catchers for tabloids. And what newspaper would dare try to sell a morning edition without the daily horoscope guide? Yes, astrology may be second-rate science, but it's a first-class business — born under the sign of the dollar, with profits rising.

The bottom line

Although it's a fact that a market for astrological paraphernalia and predictions exists, a 2001 Gallup Poll revealed seven out of 10 Americans do *not* believe in astrology. Of course, neither the marketplace nor opinion polls can resolve the underlying issue: How well does it work? Is astrology fact or fiction?

A comprehensive study in 1979 collected predictions in astrology magazines and horoscope guides during a 5-year period. Out of a total of more than 3,000 predictions noted, only 338 — or about 11 percent — were fulfilled as published. Would you rush out and buy a car if one out of every 10 cars made actually worked? Probably not.

So if ever you're tempted to pick up the newspaper and read your horoscope, remember: astrology is — by every scientific and rational test — fiction.

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BY MARTIN RATCLIFFE AND ALISTER LING

DECEMBER 04

Although most of the action this month occurs in the predawn hours, beautiful Saturn commands the late evening sky, and a new comet gleams after darkness falls.

Bright meteors blaze a trail

The strongest meteor shower of the year peaks December 13/14. The Geminid shower typically surpasses the more famous Perseid show in August. Under a dark sky after midnight on the night of peak activity, you can expect to see a "falling star" about every minute, on average. Slamming into Earth's atmosphere at speeds of 22 miles per second (35 km/sec), pieces of rock the size of peas burst into long fiery swords that can rival Jupiter or Venus in brightness. Meteoroids the size of sand grains produce streaks equal to the brighter stars. The majority of Geminid meteors glow around 4th or 5th magnitude, like the brighter stars in the Pleiades, and can be seen only from a location well away from city lights. This year, the Moon cooperates, setting around 6 p.m. on the night of the shower's peak.

A GEMINID FIREBALL BLAZES over the Kansas countryside in 1979. Conditions for this year's Geminid shower should be nearly ideal. RICK SCHMIDT

Geminid meteors appear to radiate from the constellation Gemini the Twins. As darkness falls, Gemini is just rising in the northeast. The longest trails streak overhead because we see the meteors broadside instead of almost head-on. As the night progresses, Gemini climbs higher, and the number of observed meteors climbs.

Evening observers can expect a treat this month, as Comet C/2004 Q2 (Machholz) brightens to naked-eye visibility. Glowing at 5th magnitude and sporting a growing tail, this snowball sails north to the right (west) of Orion's shield. When he first laid eyes on it, comet hunter Don Machholz noted a dim, 11th-magnitude fuzzball. In January, the comet should glow around 4th magnitude close to the Pleiades.

Saturn rises in the east after evening twilight fades. Look for a bright, pale-yellow "star" that doesn't twinkle. The smallest telescope shows the elongated shape of the rings, but plan to study the planet later in the evening. You'll see a steadier, more detailed image when Saturn floats high above the worst of the turbulent air close to the horizon.

An equally dazzling sight awaits observers near dawn December 7, when the Moon occults Jupiter. The gas giant's disk and each Galilean moon gets swallowed by the crescent Moon's bright limb, then some minutes later, they reappear from behind the unlit portion.

Unfortunately for the western third of North America, the action's over before the group rises. Console yourself with a lovely conjunction between the Moon and planet. Lunar occultations of planets happen rarely — few observers have seen more than ten in their lifetime. North Americans will have to wait until September 2016 to see the Moon occult Jupiter again.

The morning sky remains a hotbed of planet activity throughout December. Watch as Venus and Mars pair up during the first 10 days of the month. It's a pity the only time Mars gets this close to Venus is when the Red Planet lies on the far side of the Sun, just an echo of its possible glory. Mars glows 100 times fainter than the morning star.

Innermost Mercury proves easier to see than feeble Mars. As Christmas approaches, look to the lower left of Venus for a yellowish dot. On the 18th, you'll likely need binoculars to spot Mercury, but by the 22nd, it will be a snap to find with the naked eye.

Watch for the slow dance Mercury makes with Venus. The fleet-footed planet pops into the twilight glow and soon climbs above Venus. Then, during the first week of January, it makes a tight turn and slides below the morning star.

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AutoStar® – LNT™ – SmartFinder™

When you ask owners what they like most about their Meade LX90 telescope they will invariably reply, "excellent optics, incredible pointing and tracking accuracy, portability and of course – AutoStar." The LX90 was rigorously tested and reviewed by Sky & Telescope and Astronomy Magazine. Here is what they wrote regarding their test results:

DIFFRACTION-LIMITED OPTICS

The LX90 performed beautifully on splitting colorful and close double stars... Antares is easy to split in an 8-inch. What makes it difficult to resolve sometimes is not the separation (3"), but the difference in brightness between the 1st-magnitude primary and its 7th magnitude companion. The LX90 split it with ease and revealed the duo's nice orange-blue color contrast as well... The optics in the LX90 were defect-free." ***– Astronomy Magazine***

POINTING & TRACKING ACCURACY

"The altazimuth tracking was excellent. One evening I centered the Whirlpool Galaxy, M51, in the eyepiece and let the scope track unattended as the galaxy rose in the northeast and passed near the zenith. After more than four hours it was still dead-center in the field... The computer pointing is also remarkably accurate." ***– Sky & Telescope Magazine***

AUTOSTAR

They make it easy for beginners to explore the sky and grant experienced observers more time looking at objects than hunting them... Having AutoStar at my fingertips easily tripled the number of targets I viewed in the space of a few hours. A key feature for experienced observers, you can observe more targets in a given time. ***– Astronomy Magazine***

ASTROPHOTOGRAPHY

With a strong background in astrophotography, I was particularly interested to see if the LX90 would live up to its claims. The short answer? It certainly does, and then some." ***– Sky & Telescope Magazine***

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EasyAlign™ with SmartFinder™

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Viewfinder	8x50 Optical & LNT Red Dot
AutoStar	#497
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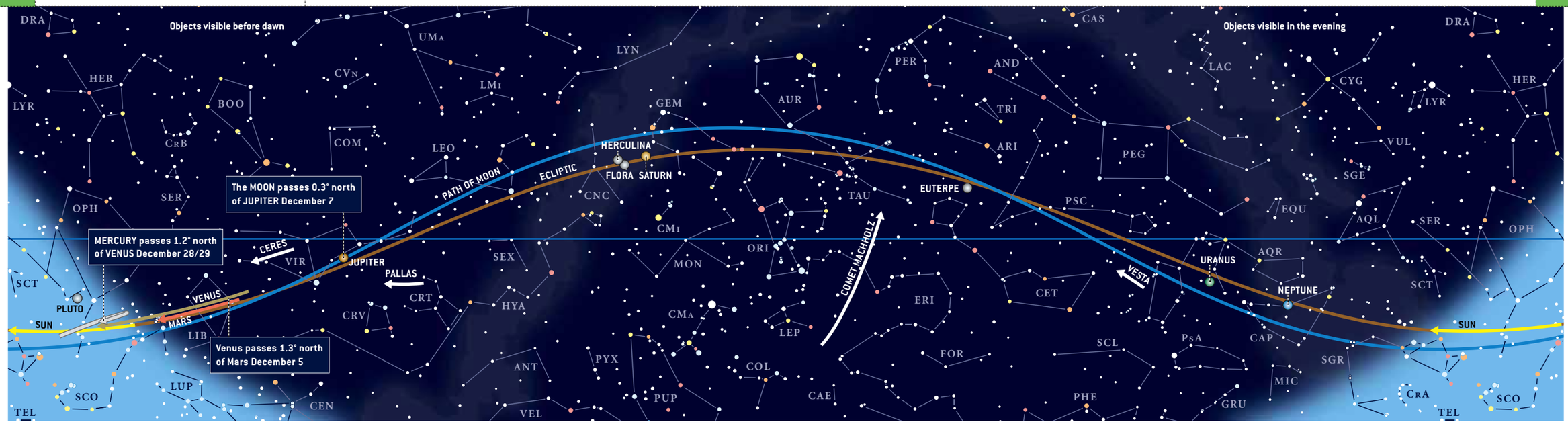
Planets this month

This map unfolds the entire night sky from sunset (at right) until sunrise (at left). Arrows and colored dots show motions and locations of solar system objects during the month.



[13] [12] [11] [10] [09] [08] [07] [06] [05] [04] [03] [02] [01]

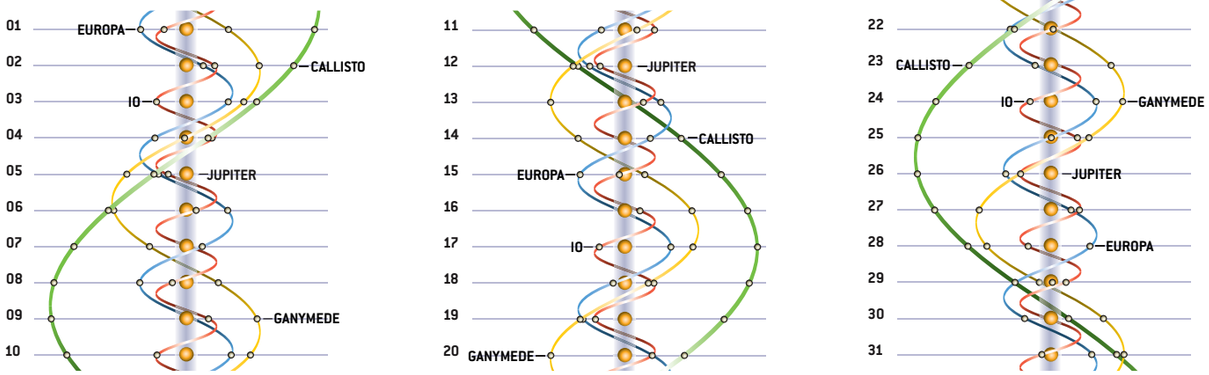
To locate the Moon in the sky, draw a line from the phase shown for the day straight up to the curved blue line.

[31] [30] [29] [28] [27] [26] [25] [24] [23] [22] [21] [20] [19] [18] [17] [16] [15] [14] [13] [12]

PLANETS	MERCURY	MERCURY	VENUS	MARS	JUPITER	SATURN	URANUS	NEPTUNE	PLUTO
Date	December 15	December 31	December 15	December 15	December 15	December 15	December 15	December 15	December 15
Magnitude	2.1	−0.3	−4.0	1.6	−1.9	−0.2	5.9	8.0	14.0
Angular Size	9.5"	6.5"	11.3"	4.0"	34.3"	20.2"	3.5"	2.2"	0.1"
Illumination	9%	66%	90%	97%	99%	100%	100%	100%	100%
Distance (AU) from Earth	0.712	1.040	1.472	2.354	5.744	8.213	20.373	30.690	31.859
Distance (AU) from Sun	0.315	0.397	0.722	1.589	5.453	9.056	20.057	30.066	30.885
Right Ascension (2000.0)	16h47.1m	17h05.3m	15h43.4m	15h21.3m	12h58.1m	7h52.2m	22h21.9m	21h03.1m	17h27.3m
Declination (2000.0)	−19°42'	−21°03'	−18°21'	−18°07'	−4°52'	20°53'	−11°00'	−16°55'	−15°09'

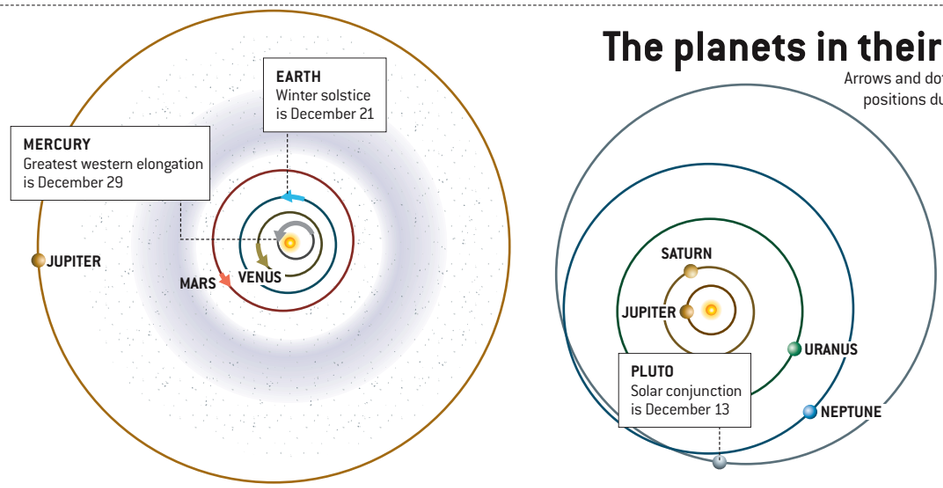
Jupiter's moons

Dots display positions of Galilean satellites at 5 A.M. EST on date shown. South is at top to match the view in a telescope.



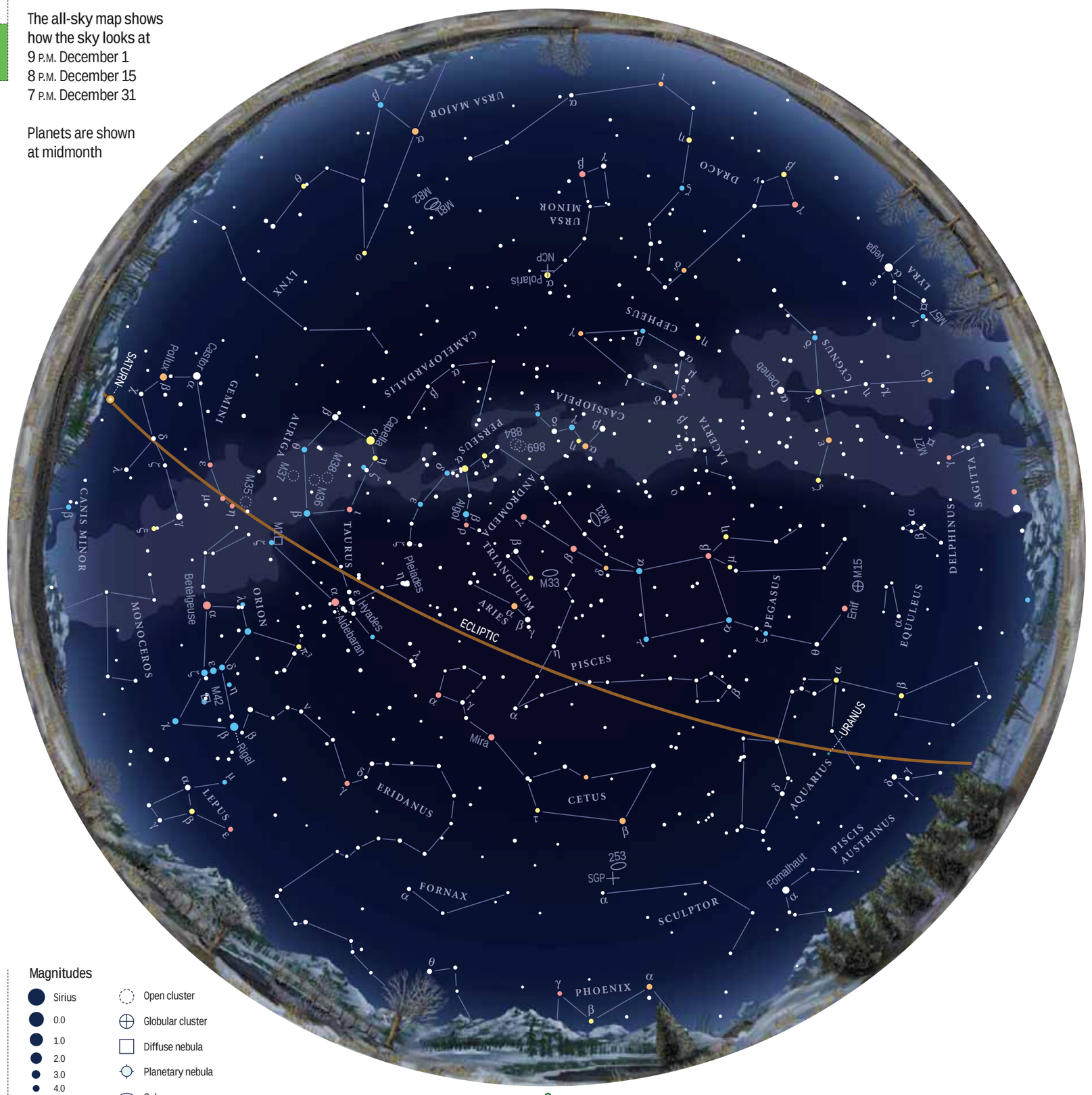
The planets in their orbits

Arrows and dots show planets' positions during the month.



The all-sky map shows how the sky looks at
9 P.M. December 1
8 P.M. December 15
7 P.M. December 31

Planets are shown at midmonth



Magnitudes

- Sirius
- 0.0
- 1.0
- 2.0
- 3.0
- 4.0
- 5.0

- Open cluster
- Globular cluster
- Diffuse nebula
- Planetary nebula
- Galaxy

This map portrays the sky as seen near 35° north latitude at times shown in the upper left corner of the page. Located just outside the map are the four directions: north, south, east, and west. To find stars above your horizon, hold the map overhead and orient it so a direction label matches the direction you're facing. The stars above the map's horizon now match what's in the sky.

december 04

SUN.	MON.	TUES.	WED.	THURS.	FRI.	SAT.
			[01]	[02]	[03]	[04]
[05]	[06]	[07]	[08]	[09]	[10]	[11]
[12]	[13]	[14]	[15]	[16]	[17]	[18]
[19]	[20]	[21]	[22]	[23]	[24]	[25]
[26]	[27]	[28]	[29]	[30]	[31]	

04 Last Quarter Moon is at 7:53 P.M. EST

05 Venus passes 1.3° north of Mars, 2 A.M. EST

07 The Moon passes 0.3° north of Jupiter, 6 A.M. EST

09 The Moon passes 2° south of Mars, 7 P.M. EST

The Moon passes 4° south of Venus, midnight EST

10 Mercury is in inferior conjunction, 3 A.M. EST

11 New Moon is at 8:29 P.M. EST

12 The Moon is at perigee (222,441 miles from Earth), 4:27 P.M. EST

13 Pluto is in conjunction with the Sun, noon EST

Geminid meteor shower peaks

15 The Moon passes 5° south of Neptune, 6 A.M. EST

16 The Moon passes 4° south of Uranus, 4 P.M. EST

18 First Quarter Moon is at 11:40 A.M. EST

21 Winter solstice is at 7:42 A.M. EST

23 Venus passes 6° north of Antares, 4 P.M. EST

26 Full Moon is at 10:06 A.M. EST

27 The Moon is at apogee (252,580 miles from Earth), 2:15 P.M. EST

28 The Moon passes 5° north of Saturn, 1 A.M. EST

Mercury passes 1.2° north of Venus, midnight EST

29 Mercury is at greatest western elongation (22°), 4 P.M. EST

For definitions of terms, visit www.astronomy.com/glossary

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THE DEEP SKY

Turn your back to the center of the galaxy and look outward to the Perseus arm of the Milky Way, home to a fiendish star, glittering star clusters, and massive clouds of gas.

In the arms of a hero

Perseus rescued the fair maiden Andromeda by using Medusa's head to turn the sea monster Cetus into stone. Bending myth to fit the starry sky, early astronomers chose Algol, the "Demon Star," to represent Medusa's head. Algol violated heaven's supposed perfection with unpredictable drops in brightness, from magnitude 2.1 to 3.4 in a matter of about 3 hours, so it's no wonder the star was so well known.

Algol's erratic behavior is only an illusion. In 1782, English astronomer John Goodricke figured out the star changes brightness because it's an eclipsing binary. With clockwork precision, a fainter star moves in front of, and partially eclipses, its brighter companion every 2.867 days.

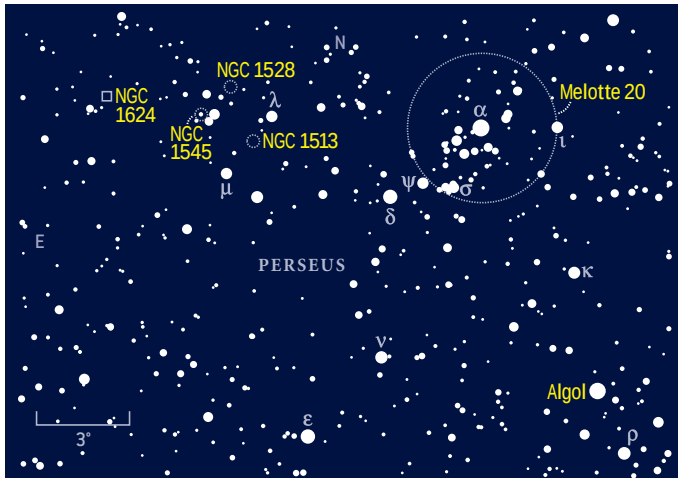
Martin Ratcliffe *is former president of the International Planetarium Society.* Alister Ling *is a meteorologist for Environment Canada.*

The puzzled casual observer, if lucky, would see a pair of eclipses separated by three evenings, followed by a 20-night gap until another pair occurred during the evening.

A favorable event for the Americas occurs Saturday night, December 11/12. Algol hits minimum at 12:28 a.m. EST, so start watching around 9 p.m. and take a look every half hour. Use just your eyes to compare Algol's brightness to that of its neighboring stars. For evening observers, the next minimum comes at 9:17 p.m. EST on the 14th, then comes a jump to January 4.

It seems that open star clusters appeal to the type-B astronomer. With the notable exception of inspiring objects like the Pleiades, most clusters are described as charming, delightful, pleasant, or lovely. To be sure, some don't stand out well from the background, but all object types have some nondescript members.

EMISSION NEBULA NGC 1624 in Perseus surrounds a youthful star cluster still in the process of forming. DIGITIZED SKY SURVEY



Striking is the word that fits the Alpha (α) Persei "moving group." Also cataloged as Melotte 20, this collection of bright stars splashes across 3° centered on Alpha Persei. The group stands out best in binoculars. A dragon leaps to mind, with yellow Alpha at the nose and orange Sigma (σ) at the tail. Telescopes just don't do this cluster justice.

Next, slide 7° east of Alpha to Lambda (λ) Per. Through binoculars under a country sky, the cluster NGC 1528 appears as an obvious circular haze just northeast of Lambda. Any telescope shows it is a rich group with a wide range of star brightnesses. You should see a dark lane and arcs of stars jumping out at you. This group punches through city skyglow fairly well.

Only 1.3° southeast of NGC 1528 lies NGC 1545. It may have only 15 to 20 members, but its arms of stars surrounding a pair of yellow luminaries impart a sense of liveliness. Nearby, NGC 1513 is a reclusive, horseshoe-shape group that hides in the Milky Way background at low power. Bump up the power to 90x or so, and you'll see more stars nicely filling in the gaps.

A birth cocoon

Star clusters are born in clouds of gas and dust. Most have shed their birth shrouds, but some, like NGC 1624, still are swaddled. You can find this youthful group easily with a Dobsonian or alt-az mount: Simply put the scope on NGC 1545 and come back exactly 20 minutes later, when Earth's rotation will have brought the cluster into view.

A 4.5-inch scope under a dark sky pulls in the gaseous cocoon with no trouble. With bigger scopes, the cloud shows up better, but its milky glow and diffuse edges leave you contemplating the many different forms of the sky's nebulae.

THE PLANETS

The Moon passes in front of Jupiter the morning of December 7, a rare treat to highlight a month that also features Saturn approaching its best.

The predawn hours provide most of the planet action during the year's final few weeks. With a late rising Sun, many people can spot the planetary spectacles at breakfast before heading to work or school. Take a step outside to spot Saturn in the western sky, and Jupiter, Venus, and Mars in the eastern sky. (The ringed planet also appears in the east during the evening.) The Moon adds drama to the morning sky December 7, when it passes directly in front of Jupiter.

Saturn grows to prominence in the east within an hour or so after it rises (it breaks the horizon around 7 p.m. local time in mid-December). Two bright stars stand above Saturn: the luminaries Castor and Pollux in Gemini the Twins. Gleaming at magnitude –0.2, Saturn appears several times brighter than the two nearby stars. On December 1, a waning gibbous Moon rises 45 minutes after Saturn. On the 26th, the Full Moon stands directly above Saturn.

Earthbound observers now can join the orbiting Cassini spacecraft in watching Saturn and its rings. From Earth, telescopes show the rings have closed a little since the planet last appeared in the evening sky. Still, Saturn's south pole and the southern face of the rings remain on fine view. The planet's disk currently spans 20", while the major axis of the rings stretches more than twice that amount, to 46".

Try spotting Saturn's still mysterious, gas-shrouded moon, Titan. Practically a planet in its own right — Titan is bigger than Mercury and Pluto — the moon shows up easily through a small scope. The Cassini spacecraft already has flown near Titan once, on October 26, and will do so again this month, on December 13.

On December 24, Cassini will release the European Space Agency's Huygens probe. On January 14, Huygens will make a dramatic descent through Titan's thick atmosphere. If all goes well, we should get a good view of the moon's surface for the first time in history. In the meantime, you can spot 8.3-magnitude Titan due north of Saturn on December 14/15 and 30/31 and due south on December 6/7 and 22/23.

Saturn's second most intriguing moon — at least at this early stage of the Cassini mission — is Iapetus. This moon appears five times brighter when it lies farthest west of Saturn (magnitude 10.1) than when it lies farthest east (magnitude 11.9). During December, Iapetus moves from the west of Saturn to the east, reaching greatest elongation December 27. The best time to spy the moon will be around December 6/7, when it lies due south of the planet.

At the beginning of December, you'll have to wait until nearly 3 a.m. to see another planet rise. That's when Jupiter,

THE MOON OCCULTS JUPITER on the morning of December 7, although the waning crescent will be fatter than it was during this August 1990 event. Find a location near you in the table below to learn when Jupiter will disappear and reappear during this month's occultation. ADRIAN NEW

/// JUPITER OCCULTATION – DECEMBER 7

{ CITY }	{ DISAPPEARANCE }	{ REAPPEARANCE }
Atlanta	3:55 A.M. EST	4:53 A.M. EST
Boston	3:59 A.M. EST	5:08 A.M. EST
Chicago	2:50 A.M. CST	3:54 A.M. CST
Dallas	2:56 A.M. CST	3:37 A.M. CST
Houston	3:06 A.M. CST	3:29 A.M. CST
Kansas City	2:49 A.M. CST	3:48 A.M. CST
Miami	4:15 A.M. EST	4:46 A.M. EST
Nashville	2:52 A.M. CST	3:52 A.M. CST
Pittsburgh	3:53 A.M. EST	5:00 A.M. EST
Washington, D.C.	3:54 A.M. EST	5:03 A.M. EST

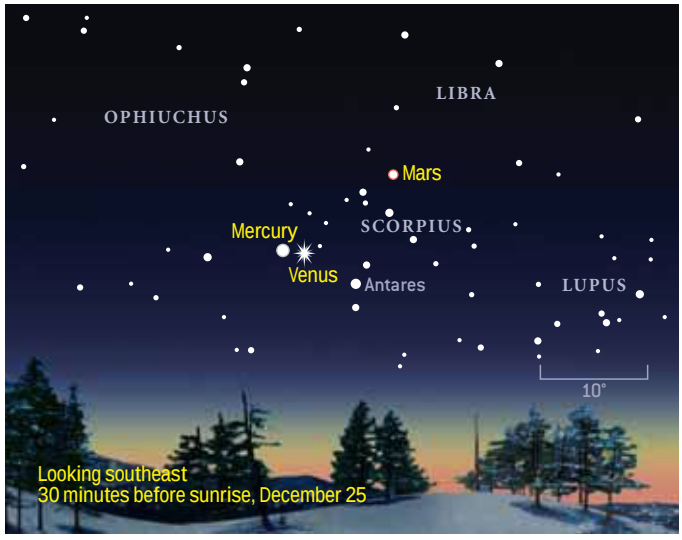
the solar system's largest planet, pokes above the eastern horizon. Jupiter lies in Virgo the Maiden all month and stands about 10° northwest of Spica, that constellation's brightest star. Jupiter shines at magnitude –1.9, far brighter than Spica or any other point of light visible before Venus rises around 5 a.m.

Your first view of Jupiter through a telescope will reveal four bright moons, unless one or more are hidden behind or transiting in front of the planet. Patient viewing will reveal plenty of features on Jupiter's 34"-diameter disk. Most obvious are two dark equatorial belts that sandwich a brighter zone. Weaker belts and zones and other subtle details appear during moments of good seeing.

For many people, the most interesting event of Jupiter's entire month comes on the morning of December 7, when the waning crescent Moon passes directly in front of Jupiter and hides it from view. The Moon frequently occults stars, but occultations of bright planets happen quite rarely and appear spectacular. Observers in most of eastern and central North America with clear skies will see this lunar occultation of Jupiter.

Most people in this region will see a total occultation, with the Galilean moons occulted either some minutes earlier or later. The planet itself disappears slowly behind the crescent Moon's bright limb. Along a narrow track in southern Texas, the Moon will graze Jupiter's disk, so observers along different parts of this path will see the Moon cover different amounts of Jupiter. See the table on the opposite page for the times when Jupiter will disappear and reappear from several representative cities. Details of the graze track and occultation times for other cities can be found on the web at *lunar-occultations.com/iota/iotandx.htm*.

The remaining morning planets cluster closer to the Sun. When Jupiter's brilliant globe has climbed up one-third of the way in the southeastern sky, Venus and Mars come into view. These two appear closest December 5, when Mars stands 1.3° south of Venus. Venus dazzles at magnitude –4.0, more than five magnitudes (a factor of 100 in brightness) brighter than Mars. The Red Planet basically appears as a moderately bright star.

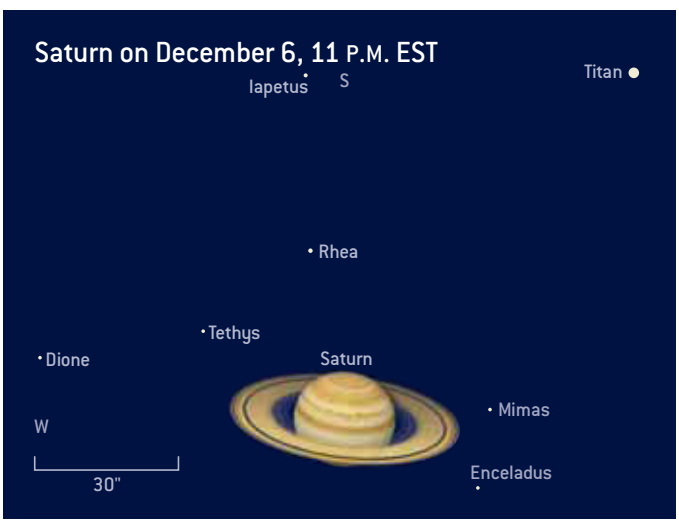


On December 9, the waning crescent Moon stands 8° west of Venus, with Mars 2° closer to the Moon. The following morning, the Moon lies 7° directly below Venus. The Moon's delicate crescent will be barely visible in the rapidly brightening sky an hour before sunrise. As December moves on, Venus falls farther away from Mars each morning.

By year's end, Mars lies 7° northwest of its ancient rival, Antares, the brightest star in Scorpius. The Arabic name Antares translates into English as "Rival of Ares," Ares being the Greek god of war — the same role played by the Roman god Mars. Mars does not yet make a good target for telescope owners because its disk appears a meager 4" across. However, by late 2005, Mars will return in a fine opposition. This month, it shines at magnitude 1.6, a half magnitude fainter than its stellar rival.

During the third week of December, as Venus continues to sink toward the horizon, Mercury rises up to greet it. The innermost planet reaches greatest western elongation December 29, coincidentally, the same day it passes just 1.2° north of its companion. Mercury then shines at magnitude –0.3.

Venus and Mercury perform an elegant waltz during the last week of December. On the 25th, a telescope reveals Mercury's half-lit disk lying a scant 2° from Venus. By the first week of 2005, Mercury's phase will have fattened to 75-percent lit. Venus, on the other hand, appears 92-percent lit. Simple geometry tells us that since the same Sun illuminates both planets, Mercury must be closer to us than Venus, with Venus lying on the far side of the Sun and consequently showing us a nearly full phase.



METEORS AND MOONS

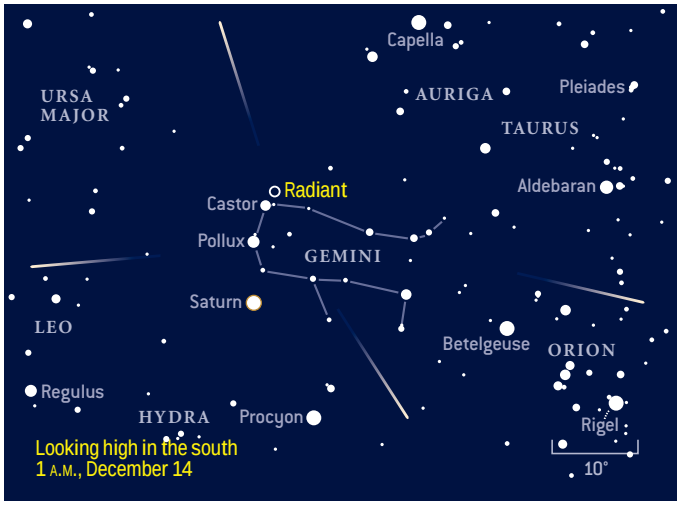
The year's top meteor shower sends a plethora of shooting stars our way around midmonth. As the Moon waxes to First Quarter, look for an ancient crater in the southern highlands.

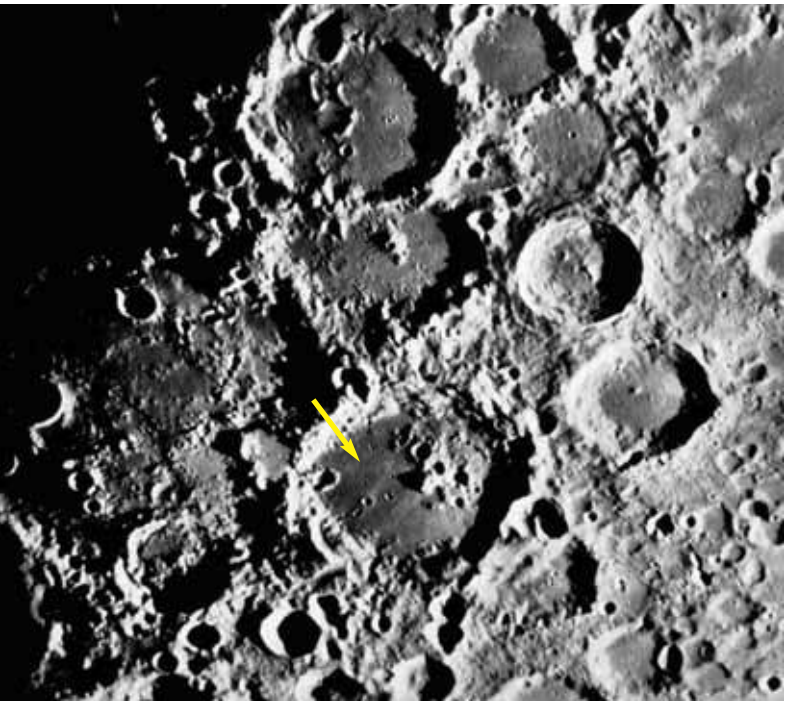
Twin fireworks

If the weather cooperates in mid-December, this should be a banner year for the Geminid meteor shower. The action peaks on the night of December 13/14, just 2 days after New Moon, so the biggest source of natural light pollution won't interfere at all. Dark skies will allow meteor viewers to see the fainter members of this active shower. Geminid activity in recent years has outpaced the more famous Perseid meteor shower in August, although the summer timing of the latter tends to encourage more viewers.

For most observers at mid-northern latitudes, observing the Geminids requires a more adventuresome spirit than what's needed for a balmy Perseid star party. Be sure to bundle up to keep the cold at bay. Layer on the warmest clothes you have, and bring along a thermos of hot coffee, tea, or chocolate. You may want to head inside every hour or so to warm up, but don't turn on any lights or you'll ruin your dark adaption.

At its peak, the Geminid shower generates one, or sometimes two, meteors per minute, on average, with a good percentage of bright meteors. The peak occurs December 13 around 22h UT (5 p.m. EST), so people in Europe and Asia will get the best view. However, the Geminid shower has a broad peak, and observers in the Americas should see an excellent show. The constellation Gemini, from which the meteors appear to radiate, rises in the northeast around 6 p.m. local time and passes nearly overhead shortly after midnight, the best time to observe this shower. One thing is for sure: If you sleep through the Geminids, you won't see any meteors. So brave the cold — the experience will give you plenty to talk about during the holiday season.





THE CRATER WALTER (arrow) sports a large central peak and several internal, secondary craters. FROM *THE CONSOLIDATED LUNAR ATLAS* (LPL/UA)

A highland depression

The giant, ancient, walled plain Walter sits in the lunar highlands in the south-central part of the Moon. In fact, it lies directly on the Moon's central meridian, the line of 0° longitude that bisects the visible hemisphere from north to south pole. Walter sports a massive central peak that casts a long shadow across the crater floor as the Sun rises over the region. (Because Walter lies on the Moon's central meridian, sunrise occurs at First Quarter phase — on the 18th this month.)

East of the central peak lie three large secondary craters, and many other smaller impact scars dot the surface. Walter's western wall appears to have a breach, with a flat lava plain lying just to its west where the crater joins with another ancient walled plain, Deslandres. The region surrounding Walter is mountainous. The crater walls themselves rise nearly 13,600 feet (4,130 meters) above the crater floor. If you look carefully, you'll notice Walter is slightly oval. It actually is shorter along it's north-south axis, which spans 82 miles (132 km), than its east-west axis, which measures 87 miles (140 km).

COMETS AND ASTEROIDS

A moderately bright new comet should brighten to naked-eye visibility this month. Meanwhile, a pair of main-belt asteroids plies the early winter sky near Saturn.

An amateur discovery

Robotic search telescopes certainly have their strengths. All you have to do is look at the comets we've highlighted during the past couple of years to realize that the NEAT and LINEAR search programs now find the majority of comets that come within range of backyard scopes. But human comet hunters continue to make important discoveries.

Late last August, amateur astronomer Don Machholz was patrolling a region of sky closer to the Sun than the search programs usually go. There he discovered a fuzzy patch of light glowing at 11th magnitude. Now, Comet C/2004 Q2 (Machholz) is rapidly approaching both the Sun and Earth. Astronomers predict it will brighten significantly, becoming a nice sight through binoculars and just visible to the naked eye under a dark sky. It should peak during January, reaching 4th magnitude as it passes near the Pleiades star cluster.

Once we hit the second week of December, the glaring light of the Moon will not interfere with evening observations. To locate Comet Machholz, start at the 2nd-magnitude star Delta (δ) Orionis, the westernmost star in Orion's Belt, make a line through brilliant blue-white Rigel, and then continue in that direction a little farther than the angular distance between Delta and Rigel. After December 16, the Moon's light will interfere more and more.

Bump up the power to see if there's any activity near the comet's core. Often you will see a star-like point, called the false nucleus, because a bright shroud of sunlit dust hides the real nucleus.

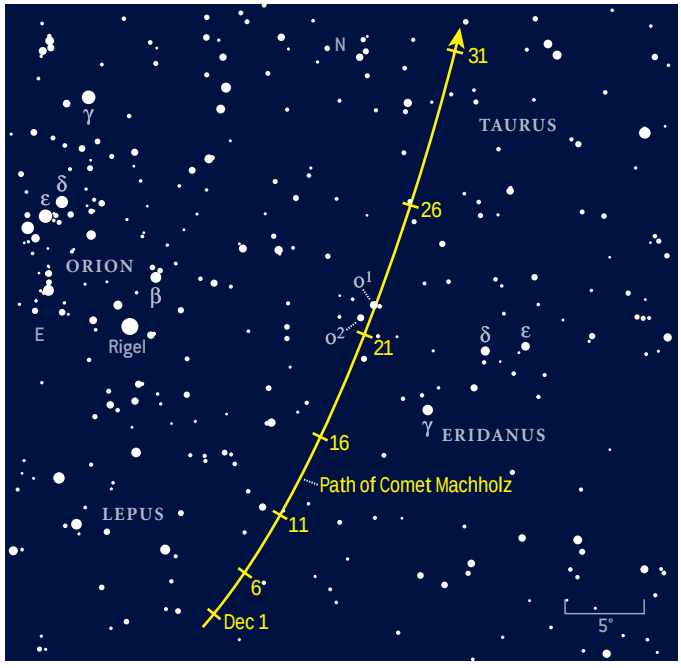
An eye looks back

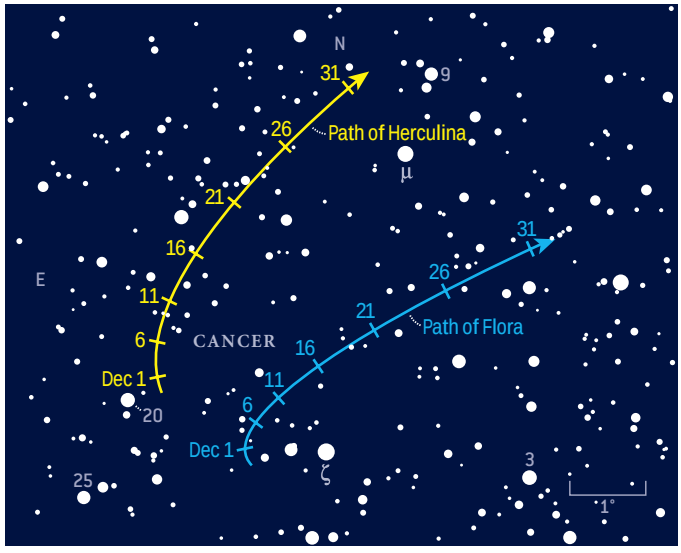
While you're following Comet Machholz, stop and take a look at the bright planetary nebula NGC 1535. An 8-inch telescope should begin to show its pale green-blue color. With averted vision, our eyes make out faint shapes but are limited to seeing shades of gray. By staring directly at an object, we can detect color and increase our ability to see detail. You'll get the most out of your telescope if you use both techniques.

Rocks on a crab shell

Not far from Saturn this month, you can find a pair of bright asteroids. Both 8 Flora and 532 Herculina reside in the main belt of asteroids between the orbits of Mars and Jupiter. Flora measures 86 miles (138 km) across, while Herculina spans 129 miles (207 km).

Flora glows at magnitude 9.1 in mid-December and Herculina at magnitude 9.7. That makes them about the same brightness as the faintest stars shown on the finder chart. The easiest way to identify them is by their telltale motions from one night to the next. Make a sketch of the field, noting the positions of about a dozen stars, then come back a night or two later and see which objects moved.





While you're in the area, swing your scope to the triple star system Zeta (ζ) Cancri. It's an easy pair with a third speck tucked tightly against the luminary.

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ASK ASTRO

White and black dwarfs, Blue Moons, finding asteroids

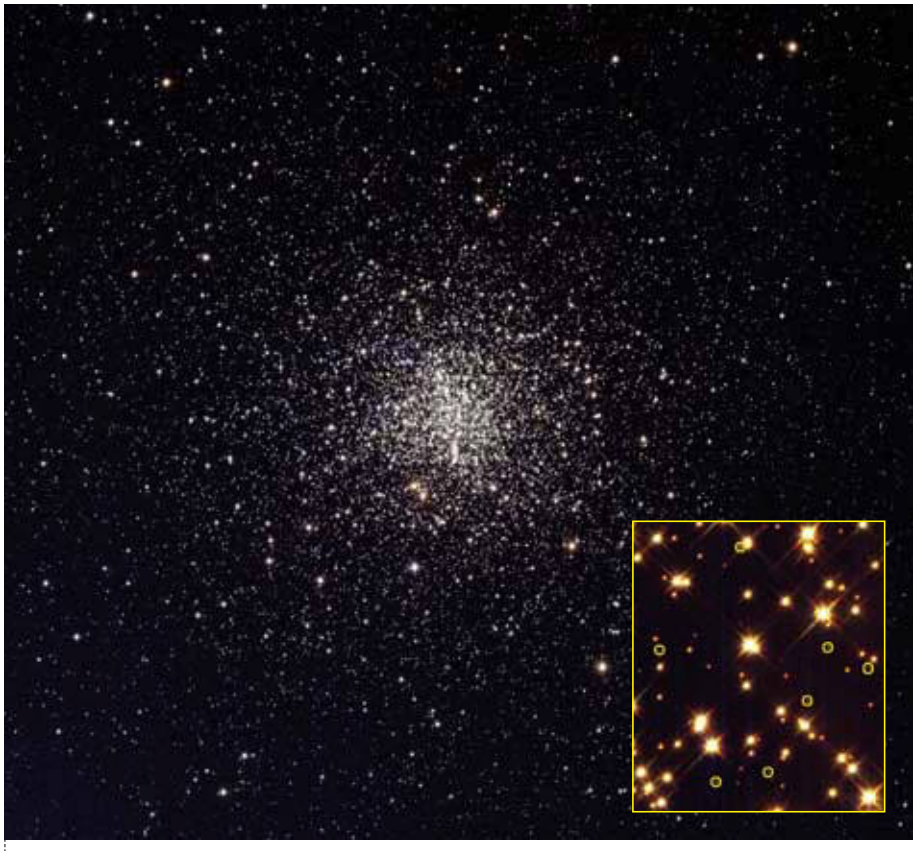
WHITE AND BLACK DWARFS

How long does it take for a white dwarf to turn into a black dwarf?

— D. G. VIEIRA, SANTA BARBARA, CALIFORNIA

A star spends most of its life fusing hydrogen into helium and, later, helium into carbon and oxygen. All but the most massive stars blow off their outer layers, forming planetary nebulae and revealing hot stellar cores. This lump of carbon and oxygen ash, the size of Earth yet still 60 percent of the Sun's mass, glows white-hot at over 100,000 kelvins and has a visible luminosity just 1/30 of the Sun's. Such a star is called a white dwarf.

A white dwarf has no energy source other than the heat left over from its birth. Just as a red-hot burner on your stove fades and cools when turned off, a white dwarf becomes steadily cooler and fainter as it ages. After 2 billion years, its surface temperature has dropped to 8,000 K and its luminosity has faded to 1/4,000 of the Sun's. The white dwarf's center has cooled to a point where the carbon and oxygen begin to crystallize. Five billion years later, the entire core of the star is crystalline: a true diamond in the sky — at a whopping 6 billion trillion trillion carats.



THE GRAND STARBALL M4, a globular cluster in the constellation Scorpius, lies about 7,000 light-years away and may be the nearest such cluster to us. Astronomers estimate it holds about 40,000 white dwarf stars. *Inset:* In 1995, astronomers used the Hubble Space Telescope to find 75 of M4's white dwarfs. Several are circled in this close-up of the cluster that measures just 0.63 light-year across. NOAO/AURA/NSF; *INSET:* NASA/HARVEY RICHER, UNIVERSITY OF BRITISH COLUMBIA, VANCOUVER

A white dwarf aged 15 billion years — that is, older than the current age of the universe — will cool its outer layers to a few thousand degrees, and its luminosity will drop to about 1/100,000 of the Sun's. Its extremely dense, crystalline core will have cooled to where quantum mechanics dominates how the star continues to lose heat. Its crystal lattice cools quickly through a process known as Debye cooling; the white dwarf fades almost completely from sight. Although the term is not well-defined, we can safely call this cold, crystallized, and exceptionally dim star a black dwarf.

Such steady cooling makes white dwarfs useful tools for determining the ages of star clusters and even the Milky Way Galaxy. For example, a study of white dwarfs in open star cluster M67 found many white dwarfs with temperatures hotter than about 6,000 K, but none cooler than this. A white dwarf takes about 4 billion years to cool to 6,000 K, so we can conclude that the cluster is around 4 billion years old.

A similar search for white dwarfs in globular cluster M4 found a cluster age of 13 billion years, and searches for white dwarfs in the disk of the Milky Way give it an age less than 11 billion years, noticeably younger than the globular cluster.

A star cluster's first white dwarfs are born from stars with relatively short main-sequence lives — about 50 million years. The progenitor's life span is neglible when compared to the billions of years its remnants have existed.

White dwarf ages of star clusters have helped refine complicated models of stellar

evolution, which then are used to study the ages of distant star clusters and even entire galaxies, where white dwarfs are far too faint to be seen. — KURTIS A. WILLIAMS, STEWARD OBSERVATORY, UNIVERSITY OF ARIZONA

BLUE MOONS

How often does a Blue Moon occur, and when will there be another?

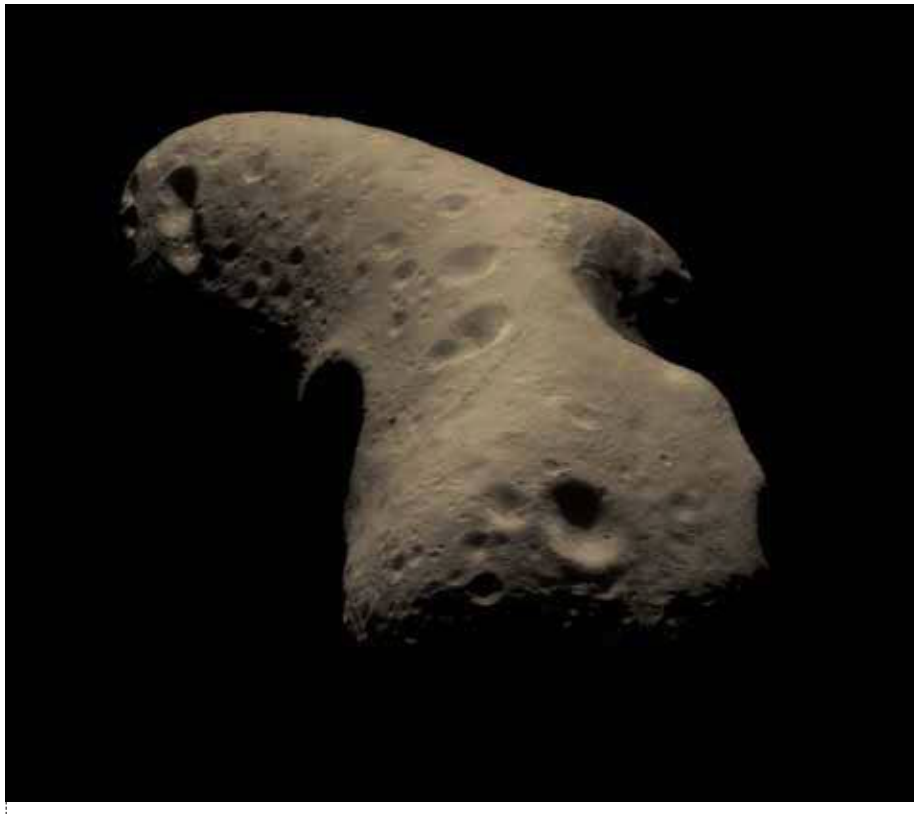
— JULIE MILLER-KLINE, OMAHA, NEBRASKA

What most people mean when they speak of a Blue Moon is the second Full Moon occurring in a single calendar month. This meaning, which dates back to 1946, grew out of a more complex tradition found in farmers' almanacs in the 19th century.

Full Moons recur every 29.53 days, just enough for a full cycle to fit snugly within a calendar month every now and then. Blue Moons recur every 2.4 years on average, with about 41 typically occurring each century. The last Blue Moon occurred July 31, 2004, and the next two — on June 30, 2007, and December 31, 2009 — will finish out the decade. Blue Moons can occur twice in years when February, the shortest month, has no Full Moon. This next happens in 2018.

Time zones add an interesting complication. Astronomers calculate the instant of Full Moon using Universal Time (UT), a standard that is, for our purposes here, equivalent to Greenwich Mean Time. If you happen to live in a time zone far enough away from Greenwich, England, shifting the UT time of Full Moon to your local time may be enough to advance the date to the first day of the new month, which means it's no longer a Blue Moon. Depending on your time zone, the Blue Moon of July 2004 occurred in either July or a month later, with the second Full Moon of August.

There are no real observational consequences — a Blue Moon doesn't look blue, and the Moon appears essentially the same for many hours before or after it reaches Full phase. So, unless you really like this sort of thing, we suggest sticking to the UT times and dates and not really worrying about whether a Blue Moon is truly blue for you. — FRANCIS REDDY, ASSOCIATE EDITOR



DOOMSDAY ASTEROIDS probably number close to 1,000, astronomers believe. Eros, an oddly shaped rock about 21 miles (33 kilometers) long, is among the largest of the asteroids that pass near Earth. In February 2000, NASA's Near Earth Asteroid Rendezvous spacecraft orbited Eros, returning images combined to make this striking portrait. NASA/JHUAPL

FINDING ASTEROIDS

When will search programs find more than 90 percent of near-Earth objects? What scopes monitor skies in the Southern Hemisphere? Who funds the searches? — DOUG KAUPA, SPOKANE, WASHINGTON

The task of finding and tracking large near-Earth objects (NEOs) more than 1 kilometer (0.6 mile) across has been assigned to the Spaceguard Survey, an international collaboration of asteroid search programs. The most prolific facility by far is the Lincoln Near-Earth Asteroid Research (LINEAR) survey, which is located near Socorro, New Mexico. LINEAR accounts for well over 50 percent of all NEO finds since it started scanning the sky in 1998.

As of the end of 2003, the Spaceguard Survey had discovered just over 700 near-Earth asteroids larger than 1 km wide. Current estimates put the total number of such objects at about 1,000 — give or take 100 — so we're about 70 percent there. At the present discovery rate, Spaceguard should reach the 90-percent mark in late 2008 or 2009 — on schedule and within budget. (See "Killer impact" on page 38 for more detail.)

The 60-centimeter Uppsala Schmidt telescope at Siding Spring Observatory in Australia has been hunting asteroids since upgrades were completed in March 2004. Known as the Siding Spring Survey, it forms a southern complement to the Catalina Sky Survey operated by the Lunar and Planetary Laboratory at the University of Arizona.

NASA funds the North American programs, which have made about 87 percent of the discoveries so far, as well as the Siding Spring Survey. — BILL COOKE, MARSHALL SPACE FLIGHT CENTER

Tour the deep-sky universe of galaxies, nebulae, colorful stars, and beautiful clusters with a small telescope and this seasonal guide. /// IAN RIDPATH

Wander the winter sky

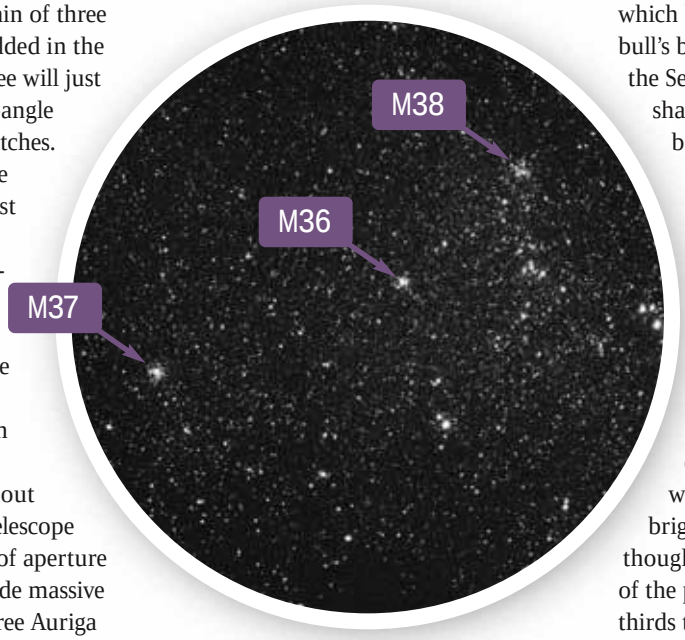
The crisp skies of winter are home to many beautiful deep-sky objects, perfect for trying out the binoculars or telescope you got for Christmas. Start by looking straight up to view the constellation Auriga the Charioteer. Its brightest star is Capella [tour stop 1], the most northerly of the 1st-magnitude stars, representing a mother goat carried by the charioteer.

Running through Auriga is a chain of three large star clusters 6° long, embedded in the stream of the Milky Way. All three will just fit into the field of view of wide-angle binoculars, appearing as hazy patches. Most prominent of the trio is the central M36 [2], which is the most condensed. Several dozen of its stars can be resolved in small telescopes.

Larger but less prominent is M38 [3], whose stars appear to be arranged in a cross when seen through telescopes — a common characteristic of open clusters. Largest is M37 [4], containing about 150 faint stars. You will need a telescope with around 4 inches (100mm) of aperture to see these clusters, which include massive red giants at their centers. All three Auriga clusters lie about 4,000 light-years away in the Perseus spiral arm of our galaxy.

Snorting the frosty night air south of Auriga is Taurus the Bull. Its face is marked by the V-shaped cluster of the Hyades [5], a grouping so large — the width of 10 Full Moons — that even binoculars can barely encompass it. The Hyades is the nearest large cluster of stars, centered 150 light-years away. Comparing its stars with those in more distant clusters is one way astronomers have built up the distance scale of the universe.

Look in the southern arm of the V for a naked-eye double, Theta (θ) Tauri. This is the brightest member of the Hyades. Although the 1st-magnitude red giant Aldebaran [6], which marks the bull's angry eye, looks as though it is part of the Hyades, it is actually a foreground star less than half as far away from Earth.



THE THREE AURIGA CLUSTERS, M36, M37, and M38, will fit into the field of view of wide-angle binoculars. 4-inch or larger telescopes should resolve orange stars at the center of each cluster. PATRICK S. McINTOSH

The bull's long horns are tipped by the stars Beta (β) and Zeta (ζ) Tauri. About two Moon diameters from Zeta Tauri lies one of the most celebrated objects in the entire sky — the Crab Nebula [7], a splatter left by a supernova that flared in 1054. Small- to moderate-size telescopes show the Crab Nebula as an elongated smear of light about six times wider than the disk of Jupiter. Because the nebula is bigger and fainter than expected, it is easily missed.

Of all the celestial sights in Taurus, the prettiest is the Pleiades [8] star cluster, which hovers like a swarm of flies above the bull's back. The group is popularly termed the Seven Sisters, although you will need sharp eyes to see more than its six brightest members, which are arranged in the shape of a mini-dipper. Binoculars and small telescopes show additional dozens of stars splashed over three Moon diameters of sky. The brightest members are hot, bluish-white giants only a few million years old.

Adjoining Taurus is Gemini, representing the Greek mythological twins Castor [9] and Pollux [10], which are the names of Gemini's two brightest stars. The stars themselves, though, are not related. Pollux, the brighter of the pair, lies 34 light-years away, two-thirds the distance to Castor.

Castor can be divided into two sparkling stars with high magnification on a telescope with an aperture of 2.4 inches (60mm). Long-term observations have shown these stars orbit each other in just under 500 years. English astronomer William Herschel detected Castor's orbital motion 200 years ago — although he had to watch it for 20 years to be sure. The two stars are moving apart, making them progressively easier to divide. Castor also has a faint red dwarf companion, difficult to identify among the background stars. Each of these visible stars is itself a close binary, making Castor an astounding sextuplet system.

At the feet of Gemini lies probably the best star cluster in this area, **M35** [11]. Under dark skies, it is just visible to the naked eye as a brighter patch in the Milky Way, but those with less favorable conditions can spot it easily through binoculars. M35 is elongated in shape and nearly as large as the Full Moon. Seen through small telescopes, its brightest stars form sprays of sparks like a fireworks explosion.

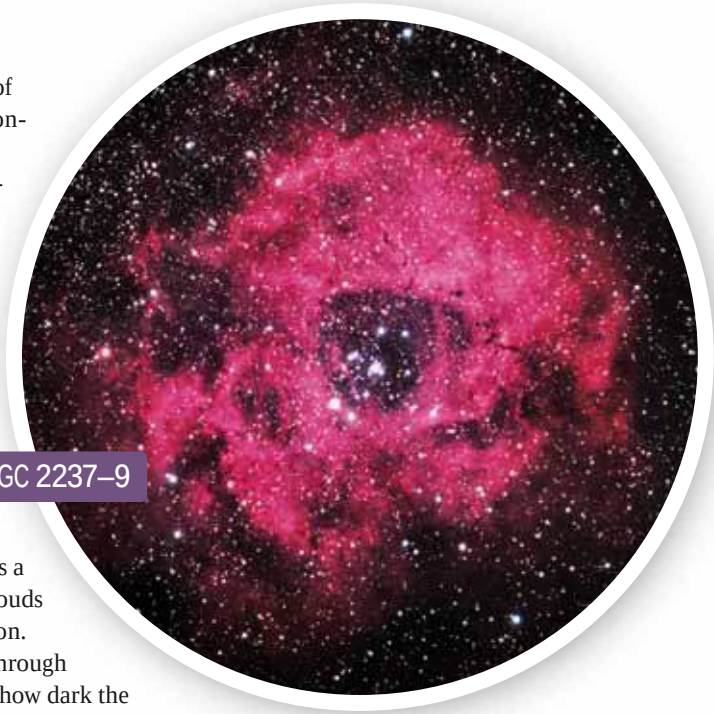
South of Taurus and Gemini is Orion the Hunter, a constellation of wonders. Its most distinctive feature is a line of three stars studding the giant's "Belt." They just fit into the field of view of normal binoculars. The rightmost of them, **Delta (δ) Orionis** [12], or Mintaka, has a companion star that can be picked out in binoculars or a small telescope. The leftmost of the trio, **Zeta (ζ) Orionis** [13], or Alnitak, is also a double star, but its companion needs a telescope of at least 75mm aperture to be seen.

At the upper left of Orion as we look at it is **Betelgeuse** [14], a red supergiant 500 times larger than our Sun, big enough to fill the orbit of Jupiter. Like all such bloated stars, it is unstable, fluctuating unpredictably in size and varying in brightness between magnitudes 0 and 1.3. It is the most obvious variable of all bright stars.

In the opposite corner of Orion lies **Rigel** [15], the constellation's brightest star. Rigel is a blue-white supergiant, a dramatic contrast to ruddy Betelgeuse. Rigel's 7th-magnitude companion is swamped by the brilliance of Rigel itself and is a challenge for small scopes, particularly in unsteady air.

Scanning south from the Belt of Orion, you will come across a complex of stars and gas clouds that defies simple description. How much detail you see through your telescope depends on how dark the sky is at your observing site.

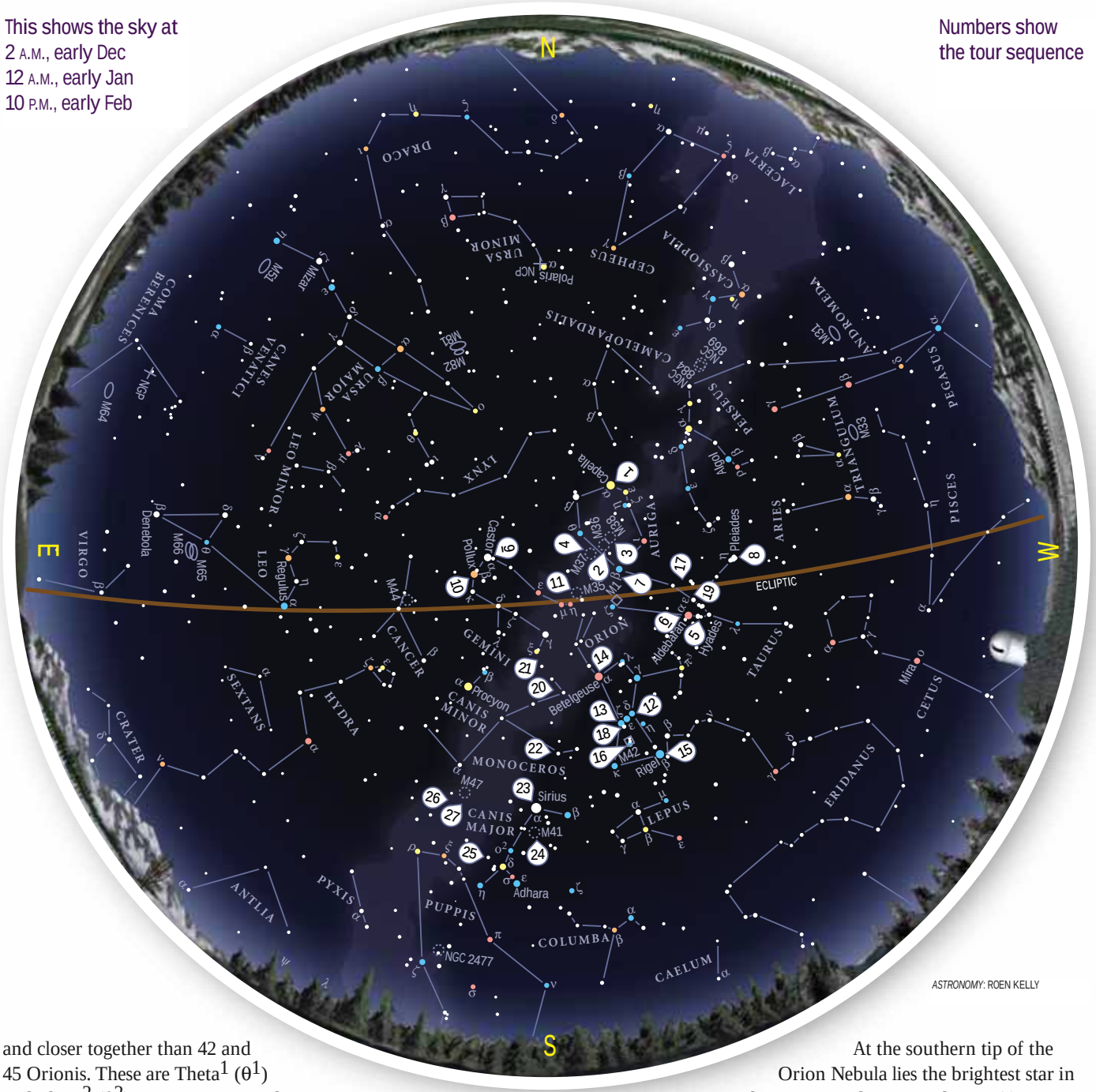
First, you should notice a faint group of stars that makes up the cluster known as NGC 1981. South of this is a widely separated pair of stars; the one to the right, called 42 Orionis, lies within a gas cloud known as the Running Man Nebula (NGC 1973–5–7). On good nights, you might be able to glimpse this object as a misty patch with binoculars. The star to the left, 45 Orionis, is not part of the cloud but lies in the foreground, about half as far away.



THE ROSETTE NEBULA (NGC 2237–9) is visible only from the clearest, darkest sites, but the cluster within, NGC 2244, is sometimes visible to the naked eye. GEORGE GREANEY

Moving south again, we come to the glowing heart of this region. You will notice another pair of stars here, slightly brighter

BRIGHT CONSTELLATIONS abound in the winter sky and house many sights on the deep-sky tour. The Pleiades lies to the right of Taurus's V. JERRY SCHAD



ASTRONOMY: ROEN KELLY

and closer together than 42 and 45 Orionis. These are Theta^1 (θ^1) and Theta^2 (θ^2) Orionis. Surrounding them is a large, misty patch of gas — the **Orion Nebula** [16]. Under good conditions, you can glimpse this nebula with the naked eye, even though it lies 1,500 light-years away. The Orion Nebula is more than two Moon diameters wide and is one of the most glorious sights in the sky. On long-exposure photographs, it resembles an exotic flower, pink and yellow in color, but to the eye, it appears white or greenish.

Ian Ridpath *is the author of* The Monthly Sky Guide *(Cambridge University Press) and the* Princeton Field Guide to Stars and Planets *(Princeton University Press).*

Theta^2 Orionis is a wide double for binoculars or small telescopes. Of greater interest is Theta^1 Orionis, a multiple star that nestles at the center of the Orion Nebula like a clutch of new-laid eggs. Small telescopes split it into a rectangle of four stars known as the Trapezium. They were born from the nebula's gas within the past few million years, and the light from the brightest of them illuminates the surrounding nebula. Behind the visible part of the nebula, more gas is forming new stars. Our Sun and planets were born from a cloud like this some 4.6 billion years ago.

At the southern tip of the Orion Nebula lies the brightest star in this region, 3rd-magnitude Iota (ι) Orionis. A small telescope divides Iota into two. Through binoculars, a fainter star glimmers to its lower right, but if you hold the binoculars steady (best done by resting your arms on something solid), you will notice **Struve 747** [17], which is also double. It's just at the limit of binocular resolution but well seen through small telescopes.

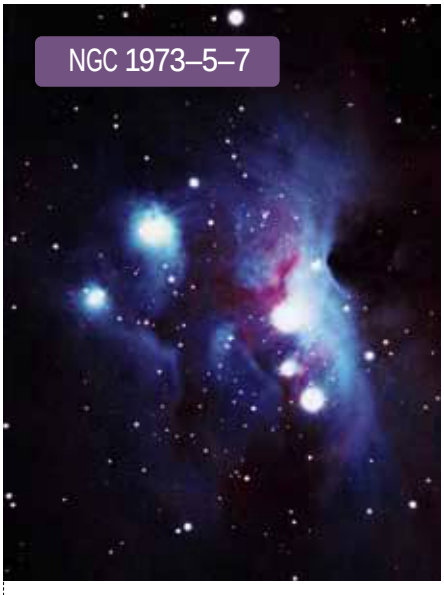
For a less-heralded treasure, look for **Sigma (σ) Orionis** [18], a seemingly unremarkable star of 4th magnitude just under the leftmost star of Orion's Belt. Through a small telescope, it appears like a planet with moons — on one side it has two companions of magnitude 7, and on the other side

is a 9th-magnitude companion, which is more difficult to see. In the same field of view is the triple star **Struve 761** [19], a triangle of 8th- and 9th-magnitude stars, completing a remarkably rich and unexpected telescopic sight.

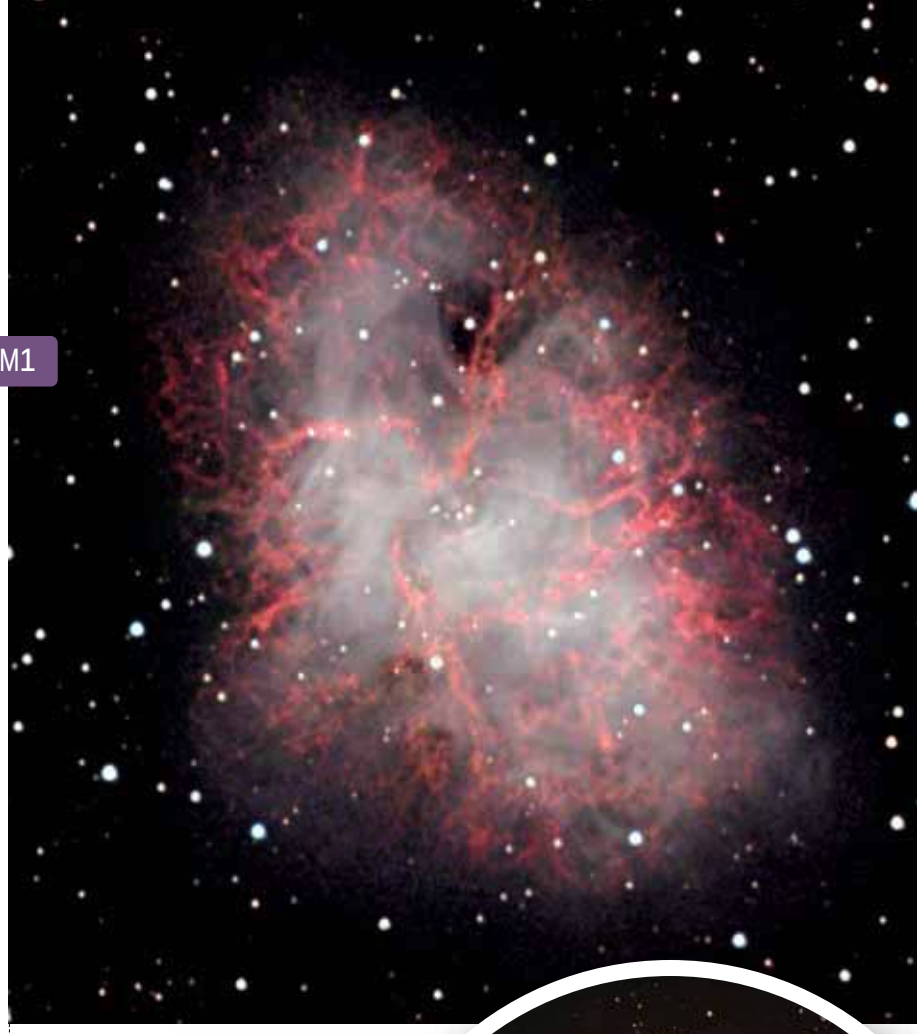
More often-overlooked treasures lie to the left of Orion in the seemingly blank area within the Winter Triangle formed by Betelgeuse, Sirius, and Procyon. Here, in the obscure constellation Monoceros, is the **Rosette Nebula (NGC 2237–9)** [20], a familiar sight from long-exposure photographs. You won't see the nebula in binoculars except under the darkest skies, but the cluster within it, NGC 2244, is easy to spot; it can be glimpsed with the naked eye under good conditions, lying a third of the way from Betelgeuse to Procyon. Its six brightest stars form a rectangle. North of NGC 2244 is **NGC 2264** [21], a triangular cluster containing the intensely hot and luminous 5th-magnitude star S Monocerotis.

Monoceros also boasts the finest triple star for small telescopes, **Beta (β) Monocerotis** [22]. At first it appears double, but crank up the magnification, and the fainter star also will be split.

No amateur astronomer needs to be introduced to **Sirius** [23], the brightest star in the sky. South of it, binoculars pick out open cluster **M41** [24], a scattering of stars as large as the Moon that was known to the ancient Greeks, who could see it unaided. Through small telescopes, M41 appears as another cluster with stars arranged in chains and with an orange giant near its center. Now turn your telescope farther south to **Tau (τ) Canis Majoris** [25], a 4th-magnitude blue supergiant surrounded by a much more compact cluster, NGC 2362.



NGC 1973–5–7 appears as a misty patch through binoculars. BUTCH TREMBLY



THE CRAB NEBULA is the remnant of a supernova that exploded in 1054. Through small scopes, it appears as a faint smear of light, about six times the width of Jupiter. BRIAN LULA

THE ORION NEBULA is visible to the naked eye under dark skies, even though it lies some 1,500 light-years away. J. C. MIRTHE

Finally, don't overlook Puppis, adjoining Canis Major. Although considered a southern constellation, its most northerly parts reach higher above our horizon than Sirius. And it's in northern Puppis that you will find open clusters **M46** [26] and **M47** [27], which appear side by side as bright patches in the Milky Way but which lie at widely different distances from us. M47, the closer of the two, appears larger and brighter, with three dozen or so stars scattered over an area similar in size to the Full Moon. M46, three times farther away, contains around 100 stars of about 10th magnitude. Both clusters are easy objects to locate with binoculars, and they're worth finding to complete your observing log this winter. Good luck!

For winter "challenge" objects, see www.astronomy.com/toc

During blackouts and between bombings, a dedicated amateur astronomer observes the night sky from a nation wracked by war. /// BY MATTHEW QUANDT

Wartime astronomy

Editor's note: Ra'ad Ali Abdul Aziz, the subject of this story, was released by kidnappers September 28, after being abducted with coworkers from an office in Baghdad, Iraq, 3 weeks prior. Please see "Aziz and three colleagues released" for information available at press time.

The story of this particular amateur astronomer begins the same as most others. Born into a financially stable family, he has two brothers and three sisters. His father worked in the finance department of a clothing store, and his mother was a secondary-school teacher. Astronomy sparked his interest when he was just 6 years old. Grade-school science classes didn't include astronomy-related lessons, so he fed his passion for the night sky by reading anything he could find about it.

His parents spoiled him with encouragement, and while they didn't share his interest, they fostered his pursuit of knowledge about the universe. Finding books on astronomy was difficult, but those he found, he devoured. There was no limit to his curiosity, his commitment, or his ambition. Besides a lack of resources, there were severe limits to what he could see in the night sky. Unfortunately, the sky above him was light-polluted in the 1970s. You see, our friend is Ra'ad Ali Abdul Aziz, and this is the story of his experience as an amateur astronomer in Baghdad, Iraq.

RA'AD ALI ABDUL AZIZ lives in Baghdad, Iraq, where he is an amateur astronomer, engineer, and humanitarian.

Bombs by day, dark skies by night

On September 22, 1980, a few weeks after Ra'ad's 11th birthday, six Iraqi army divisions entered Iran in a surprise attack intending to gain control of the Shatt al-Arab waterway at the head of the Persian Gulf — a long-contested border area

/// AZIZ AND THREE COLLEAGUES RELEASED

At press time, Ra'ad Ali Abdul Aziz and three other aid workers had just been released after being held hostage for 3 weeks.

The workers' ordeal began in the middle of the afternoon, Tuesday, September 7, when three cars pulled up to the offices of A Bridge to Baghdad, an Italian humanitarian agency where Ra'ad works. According to reports, 15 to 20 men wearing uniforms and flak jackets stopped traffic and stood watch as two well-dressed men entered the building. Witnesses described the men as having AK-47s, pistols with silencers, and stun guns.

According to Jean Dominique Bunel of the Non-governmental Organization (NGO) Coordination Committee in Iraq, which oversees aid agencies' efforts in the country, two well-dressed men pushed their way into the office, put guns to the heads of the office's unarmed guards, and grabbed four workers: two Italian women, Simona Pari and Simona Toretta; an Iraqi woman, Mahnaz Bassam; and Ra'ad.

Some witnesses reported the two men searched for the Italian women by name. They then led the four aid workers at gunpoint to the cars waiting outside. Reports say one of the armed men grabbed Bassam by the head scarf to pull her into a car.

Most accounts tell of the "professional" appearance of the kidnapping. The abduction occurred in the middle of the afternoon in the heart of Baghdad — not far from the heavily patrolled Green Zone. The group encountered no resistance before, during, or after the abduction. Witnesses also said the armed men weren't masked and were clean shaven. Typically, kidnappers wear something over their faces to hide their identities.

During the weeks following the abduction, information on the hostages' location and fate remained a mystery. Nothing was publicly discovered about either the hostages or the group that was holding them. A few statements were made by a previously unknown militant group, but the messages and demands were neither verified nor carried out.

One foreign correspondent told *Astronomy*'s Matt Quandt "the Italian (kidnappings) are the weirdest so far. No video of them is released, no official demands were made. There were a couple of claims from groups that are totally unknown and with no proof they had them."

According to an Associated Press report September 28, Italian Prime Minister Silvio Berlusconi told Parliament that the two Italians and two Iraqis had been released to the Red Cross in Iraq.

"Finally a moment of joy," Berlusconi said. "The two girls are well and will be able to return to their loved ones tonight."

An update on this tragedy-turned-triumph will be published at a later date.

between the two countries. As the army invaded by land, Iraqi MiG-23 and MiG-21 fighter jets attacked 10 air bases in an effort to cripple the Iranian air force. When the attack proved unsuccessful, Iran mounted a counterattack. Thus began the Iraq-Iran War.

From 1980 until 1982, Saddam Hussein ordered all sources of light in Baghdad shut off to minimize visual targets for Iranian bombers. According to Ra'ad, "Because of the blackout, the roof of my house became an astronomical observatory." During the first 4 months of the war, Baghdad was attacked heavily. After that, the frequency of attacks declined, allowing Ra'ad to go up to his roof and experience observational astronomy like never before.

"The sky was dark enough now that I could see the Milky Way and several nebulae clearly." He continues: "My knowledge about the sky and astronomy is due to those two years. That was the worst time for all Iraqi people. But for me, it was the time to learn the sky and constellations."

Ra'ad would take his 3.5-magnification binoculars, sky maps, a flashlight, a little table, a chair, and his 70-millimeter reflector to the roof. Each night, he would try to observe one constellation or focus on the Moon's surface features. "But it wasn't always safe," Ra'ad adds. "Several times, Iranian aircraft attacked Baghdad while I was on the roof." Despite the danger, this exposure to a dark sky fueled Ra'ad's interest and motivated him to learn more about the cosmos.

In March 1982, the Iranian army split the Iraqi forces, causing the Iraqi military to retreat. In June, Iraq offered a peace treaty to end hostilities between the two countries. Iran, influenced and encouraged by its momentum, rejected the treaty and committed itself to removing the Iraqi regime from power. This decision would prolong the war for 6 more years and result in one of the bloodiest wars since World War II: More than half a million lives would be lost by its end in 1988.

A limited peace

By the time Ra'ad was 14, he was reading college-level astronomy textbooks just to "enrich my knowledge of the heavens." Ra'ad continued his rooftop observations

Matthew Quandt *is an assistant editor of* Astronomy.

THE TRAPPINGS OF WAR are a familiar sight in Iraq, which has been engaged in a serious conflict in each of the past three decades. During the Iran–Iraq War, the Gulf War, and the 2003 U.S.-led occupation of his country, Ra'ad fostered his interest in astronomy, observing when he could. RA'AD ALI ABDUL AZIZ

/// WRITER'S REFLECTION

"We are safe and fine," was the subject of Ra'ad's September 4 e-mail to me. The message continued, "Our office was attacked on Thursday [September 2] by a missile. . . . The attack was done by three missiles. Two of them attacked Ibn Al-Haitham hospital, very close to our office, and the third one came to our office." The office Ra'ad refers to is A Bridge to Baghdad's, the same office he was working at when he was kidnapped September 7.

For 3 weeks, Ra'ad's family and friends did not know who was holding him hostage, where he was, or his condition. Some reports claimed Pari and Toretta had been murdered — with no news about Ra'ad.

Rumors flew about the fate of the two Italian women. Two different groups, each claiming responsibility for the kidnapping, claimed to have murdered the two women just days before their release. Neither statement was verified, however, and the Italian government continued its recovery efforts.

In light of this turn of events, I'd like to share with you what Ra'ad's brother, Sirwan, told me just days after the abduction: "Ra'ad is [a] very pacifist guy. He always shared the very hard moment with the Iraqi people, he believes in the future of Iraq and the Iraqi people. I am still very optimistic and I'm sure we'll see Ra'ad again very soon." — *M. Q.*

for the remainder of the war, but they were less fulfilling after the streetlights were turned back on, in 1983.

In 1985, opposing forces began to target civilians and population centers, and Baghdad frequently was hit with air raids and missile attacks. When not on his roof or in his house with his family, Ra'ad attended school. Between 1980 and 1988, Ra'ad completed middle school and high school, and started attending the University of Baghdad, where he studied civil engineering. On August 2, 1990, during his senior year of college, Iraq invaded Kuwait. Only 2 years had passed since the end of the Iraq-Iran war.

"The social, economic, and political situation in Iraq was critical," Ra'ad explains.

"THE ROOF OF MY HOUSE became an astronomical observatory," Ra'ad explains. Between bombings, he set up his equipment there, studying star maps inside when fighting recommenced. RA'AD ALI ABDUL AZIZ

OBSERVING THE SKY is a peaceful escape for Ra'ad, who grew up and lives in a war zone. Under the cover of blackouts, he honed his skills as an amateur astronomer. RA'AD ALI ABDUL AZIZ

"Everyone knew the war would destroy everything, but at the same time, nobody could change anything. Nobody could do anything for that disaster. So I decided to take advantage of the war and the dark Baghdad sky. The best way to run away from that terrible time was to stay home and look toward the heavens."

A new conflict

In November 1990, the United Nations (UN) authorized the use of military force against Iraq in response to the attack on Kuwait. The Gulf War began January 17, 1991, with coalition forces bombing Baghdad heavily. According to Ra'ad, "bombings occurred every 15 to 20 minutes. The [night] sky at those moments became like daylight." Ra'ad's family was one of only three who stayed in his neighborhood; the other 21 families sought safety outside the city.

Exhibiting great perseverance, Ra'ad again took to his roof, "to 'enjoy' the war and the darkness of the city." Just as he did during the still, quiet, clear nights during the Iraq-Iran War 10 years earlier, Ra'ad observed the Milky Way and nebulae — the same beautiful, awe-inspiring cosmos arching over a different conflict.

When attacks did come, "the sky would light up like fireworks." Sometimes, Ra'ad was caught off-guard observing on the roof when attacks sprang up. He'd dash into the house because, as he explains casually, "bomb fragments and falling bullets are deadly."

Extreme observing

Undeterred by the dangerous situation he was in, Ra'ad decided to maximize the time he spent observing by minimizing the amount of time it took to set up his scope on the roof. He calls his technique "observe and run away."

During moments of peace, he would set up his 70mm reflector on a lightweight, easy-to-maneuver mount, then observe what he could until bombs started dropping, when he'd dash back into the house. While caught up in this cat-and-mouse game, Ra'ad regularly viewed Orion and the Orion Nebula. "I couldn't see more difficult objects then because there was no time," he explains.

He played this "game" for a few weeks, until Baghdad's Al-Daura oil refinery was attacked. During the assault, the oil tanks

exploded, igniting a fire that lit the night sky for weeks and smothered the city in thick, black smoke.

In February 1991, near the end of the Gulf War, Ra'ad earned his bachelor's degree in civil engineering. He served 11 months in the Iraqi army in an engineering unit. Because of UN sanctions against Iraq, as well as the army's own state of disarray, Ra'ad was able to leave the military to pursue his master's degree in structural engineering. He had earned his doctorate in structural engineering at the University of Baghdad by the time the U.S.-led coalition forces invaded in 2003.

A strangely wonderful night

Ra'ad continued to nurture his interest in astronomy during the relative peace between the end of the Gulf War and the start of the most recent conflict. He found tranquility among the stars. "The only thing I could do was to enjoy observing my old friends, the stars and nebulae." His wife and son fled to Bakuba, just east of Baghdad, before the 2003 invasion, but Ra'ad stayed behind.

When the lights went out in Baghdad April 3, Ra'ad handled the war-imposed darkness the only way he knew how: Armed with just his telescope, lightweight mount, *Astronomy* magazine, and camera, he climbed to his roof for some deep-sky reconnaissance.

"I heard some explosions and clashes during the night, but otherwise, it was strangely calm. That moonless night was the greatest observing event of my life." Becoming even more efficient at his technique, Ra'ad would observe, run away, and study. When explosions, shrapnel, and bullets streaked across the sky, he would retire inside to study star charts and prepare for the next break in the fighting, when he could spend more time with his cosmic friends — themselves poised silently and dispassionately far above the turmoil of Baghdad.

PLASTIC TARPS OVER THE WINDOWS protected Ra'ad and his colleagues from shrapnel when their building was struck by a missile September 2, 2004. RA'AD ALI ABDUL AZIZ

THE INVASION OF BAGHDAD by coalition forces began in April 2003. When city lights went out April 3, Ra'ad took to his rooftop. He calls that night "the greatest observing event of my life." USGS/LANDSAT 7

Hope for the future

Ra'ad now supplies his engineering expertise to help in the rebuilding of his beloved home city, building residential complexes, supermarkets, and more. He also is a guest lecturer at the University of Baghdad's College of Engineering.

He is unable to travel because of the area's instability, and he can't get outside the city for even the shortest observing run. "There are a lot of looters and thieves. Moreover, the fighters may attack any moving target, and they don't care if I am an astronomer who wants to observe," he says. "I miss the dark sky."

So Ra'ad makes due, as he has since he was a boy, by observing from his rooftop under the light-saturated Baghdad sky. His zeal for astronomy continues to flourish even in the most life-threatening of situations. "Now, when I remember that night [April 3, 2003], I wonder why I wasn't afraid of the bombing. Really, I don't know why," he says. "I just know that I forgot all about the war and just thought about the stars. I just love watching these glorious objects." A

Explore the craters named for members of the Franklin expedition, the 19th century's worst exploration disaster. /// BY ROBERT A. GARFINKLE

Polar Moon

The names of the Moon's surface

features commemorate historical figures from all branches of science and exploration. Some of the most haunting lunar monuments, however, are linked to men associated with the doomed Franklin expedition. This was an attempt by early Victorian Britain to find the fabled Northwest Passage,

a sea route north of North America from the Atlantic Ocean to the Bering Strait.

In 1845, the British Admiralty sent a two-ship expedition headed by three-time Arctic veteran Sir John Franklin to find this legendary shortcut to the Orient. No one returned. Of the 129 men on this ill-fated expedition, only Royal Navy Captain Francis Crozier is commemorated by a crater on the Moon. Yet five additional craters honor men associated with Franklin on earlier British polar expeditions or with attempts to rescue him. After recalling their stories, visiting these craters with a backyard telescope puts some flesh and bone on hard lunar rock.

Poleward bound

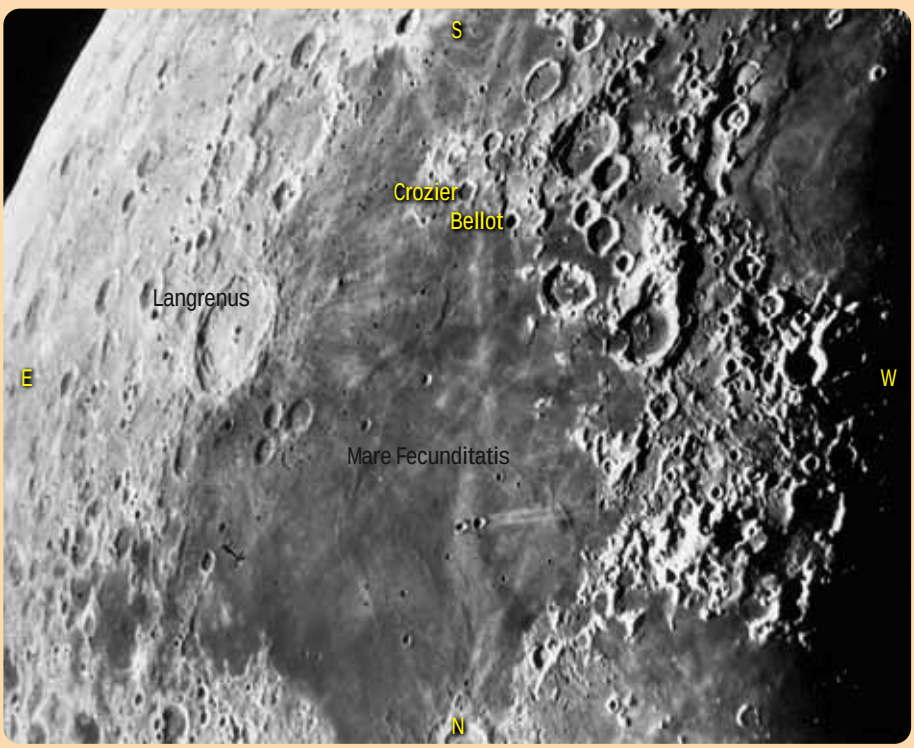
John Franklin was approaching the age of 60 in early 1845, and the Admiralty questioned his fitness to head the expedition. To this, Franklin is quoted as responding, "No, no, my lord, only 59."

His reply clearly sufficed, for Franklin was given command. In May 1845, amid great fanfare, the Royal Navy ships HMS *Erebus*, under Commander James Fitzjames, and the HMS *Terror*, commanded by Crozier, sailed down the Thames and set off across the Atlantic. The navy equipped the ships with the best ocean-going technology existing in 1845: steam-powered screw propellers, iron plates on the hull to cut through pack ice, and hundreds of pounds of canned food, enough to last 3 years. It was the best-prepared polar expedition of its time.

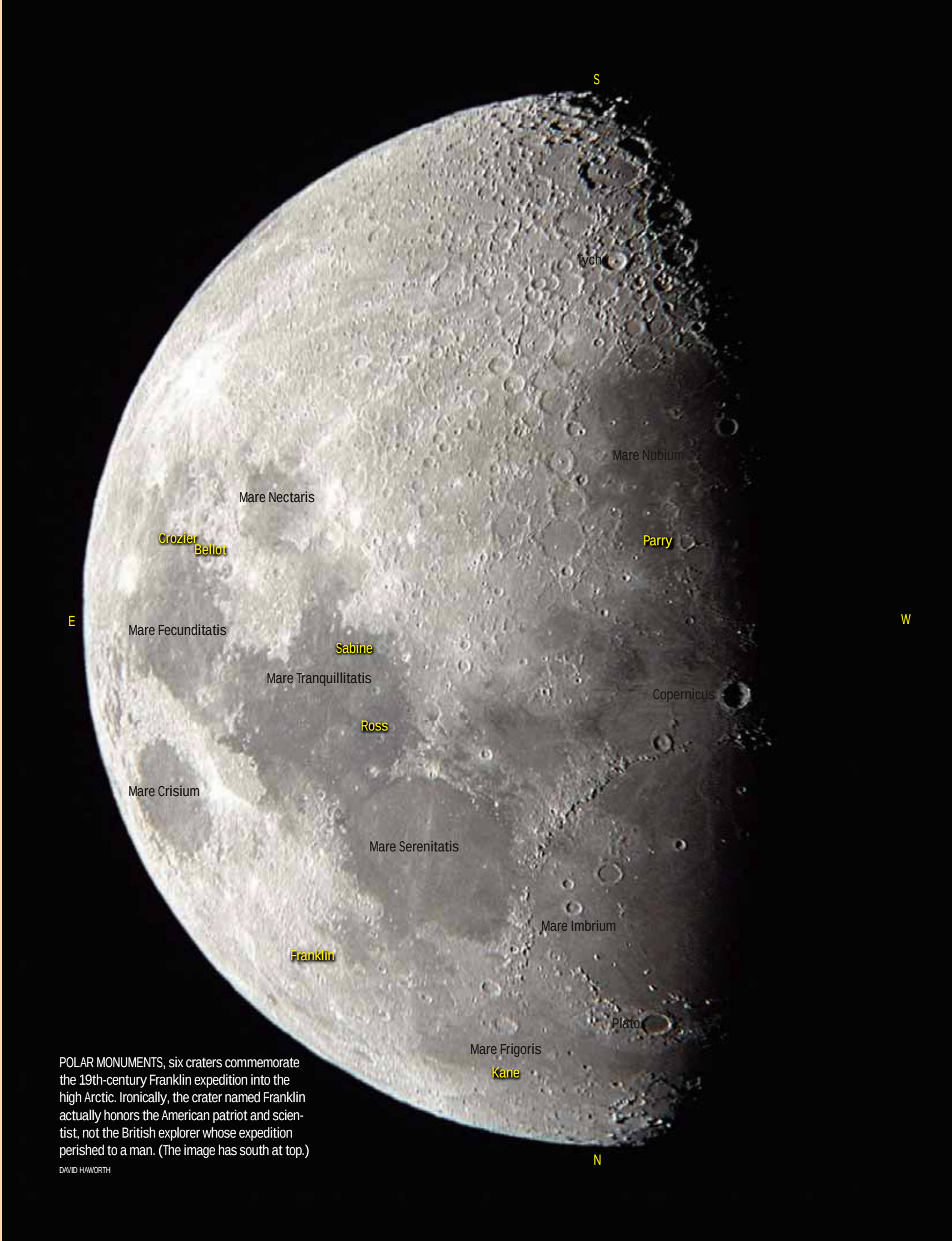
Franklin's ships were last seen by whalers in late July 1845 near the head of Baffin Bay, between Greenland and Canada. When the expedition failed to appear in Bering Strait by spring 1848, the Admiralty sent a rescue expedition headed by Franklin's longtime friend and fellow polar explorer, Sir James Clark Ross. He searched for Franklin without result in 1848 and again in 1849.

In 1859, another search team found a one-page note left by the Franklin crew

SIR JOHN FRANKLIN (1786–1847) was 59 when he launched his third Arctic expedition. NATIONAL MARITIME MUSEUM, LONDON



CROZIER AND BELLOT lie where the Sun rises over them about 4 days after New Moon. South is at top in this image, mimicking the view through most telescopes. FROM *CONSOLIDATED LUNAR ATLAS* (LPL/UA)



POLAR MONUMENTS, six craters commemorate the 19th-century Franklin expedition into the high Arctic. Ironically, the crater named Franklin actually honors the American patriot and scientist, not the British explorer whose expedition perished to a man. (The image has south at top.)

DAVID HAWORTH

MORE THAN 40 RESCUE EXPEDITIONS searched for Franklin and his crew. The HMS *Assistance*, shown here in an 1853 painting by Thomas Sewell Robins, was one of eight ships that found evidence of Franklin's winter camp and three shallow graves on Beechey Island in 1850. NATIONAL MARITIME MUSEUM, LONDON

in a cairn near Victory Point on King William Island, off Canada's northern coast. The note revealed that Franklin's ships had become locked in ice northwest of King William Island for 19 months beginning in September 1846. Captain Crozier had taken command of the expedition after Franklin died June 11, 1847. In April 1848, with provisions running low, the men abandoned the ice-bound ships and, dragging lifeboats as sledges, began an overland trek to what is now Back River on the Canadian mainland.

None of them survived.

Search parties in the 1850s, 1860s, and 1870s found the graves of only four crewmen, a couple of unidentifiable skeletons, and scattered bones. They also found mounds of empty food tins and stacks of cans containing rotting meat, the result of poor processing when the cans were sealed.

Robert A. Garfinkle's *previous article was* "Exploring Cassiopeia's bright clusters" *in the November 1996 issue. He is the author of* Star-Hopping: Your Visa to Viewing the Universe *and is currently writing a book on observing the Moon.*

A lunar world

The features honoring these Arctic explorers begin to emerge from the lunar night when the Moon is 4 days old. The crater Crozier appears first. It has a generally rectangular shape and is about 14 miles (22 kilometers) in diameter and 4,300 feet (1,300 meters) deep. (The depth is the estimated vertical distance from the floor to the highest peaks along the crater rim.) The crater lies in the mountainous region along the southwestern edge of Mare Fecunditatis. Crozier's floor consists of dark gray basaltic lava similar in shade to the mare surface.

Its namesake, Francis Crozier, entered the Royal Navy in 1810 and served on five ships before being assigned to the HMS *Fury* under Captain William Edward Parry. From 1821 to 1827, Crozier sailed with Parry on three exploring voyages to the Arctic. He served on the HMS *Cove* under the command of Captain James Clark Ross and spent the summer of 1836 in the vicinity of Davis Strait and Baffin Bay in the eastern Canadian Arctic. In 1839, Crozier was reunited with Ross on the ship HMS *Terror* for an expedition to the Antarctic Ocean. They returned to England in September 1843. Eleven days before the Franklin expedition started, Crozier was appointed captain of the *Terror*. In 1865, English selenographer William Birt added Crozier's name to the lunar nomenclature.

Swept overboard

The crater Bellot likewise becomes visible on the fourth day after New Moon and lies just a short distance northwest of Crozier. Bellot crater, also named by Birt in 1865, honors French Navy Lieutenant Joseph Réné Bellot. With an 11-mile (17 km) diameter, the crater Bellot has a very bright floor and can be detected as a glowing spot when illuminated by earthshine. The crater is 10,200 feet (3,100m) deep.

Bellot volunteered to serve on the HMS *Prince Albert* for the 1851–52 Franklin search expedition. He returned to the Arctic aboard the HMS *Phoenix* on the 1853 search. On August 18, 1853, Joseph Bellot was swept overboard by a gust of wind in the Wellington Channel, west of

Devon Island in the Arctic archipelago. His body was never found.

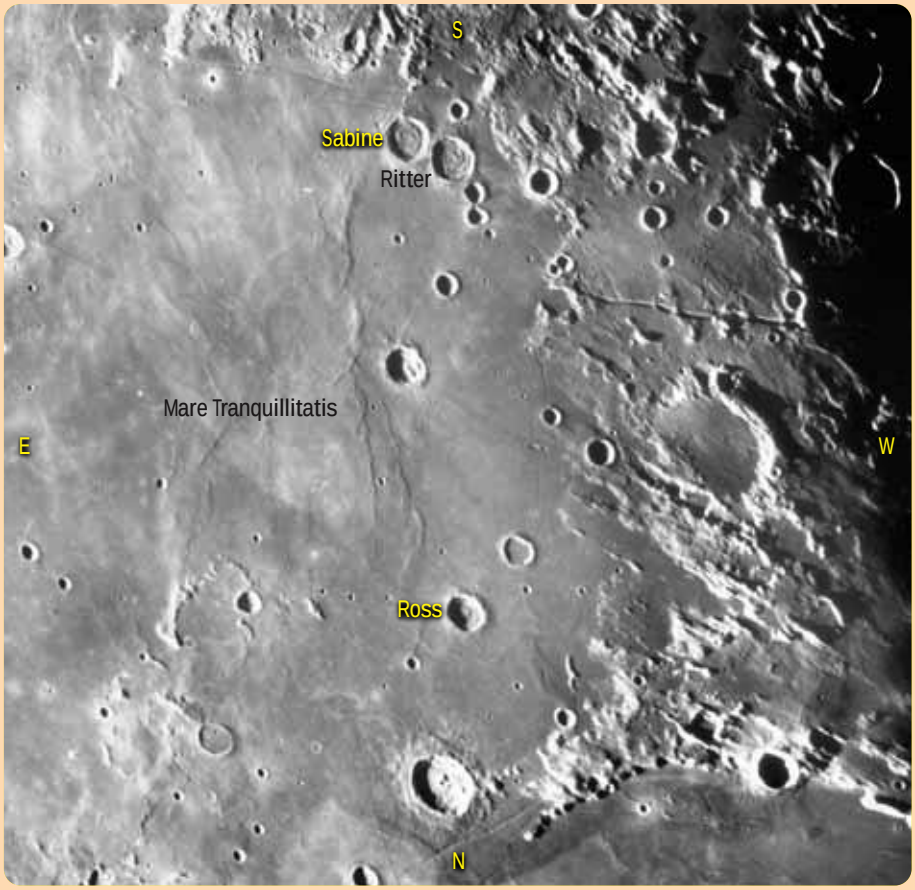
Sir James Clark Ross is honored with crater Ross, named for him in 1837 by German selenographers Wilhelm Beer and Johann Heinrich Mädler. The near-circular crater is 16 miles (26 km) across and 6,000 feet (1,840m) deep. It lies on the northwestern plain of Mare Tranquillitatis. A central peak rises to the west of the crater's center. The interior walls are bright and terraced, with narrow valleys on the eastern walls and floor. A light-gray apron of ejecta encircles the crater. Ross shows well on about the sixth day after New Moon.

As an explorer, Ross carried out magnetic surveys in both the Arctic and Antarctic. On June 1, 1831, Ross, along with his uncle, Rear Admiral Sir John Ross, discovered the magnetic north pole. Both men were involved in separate attempts to rescue Franklin. In 1847, the elder Ross wrote to the Admiralty about commencing rescue attempts, but his nephew James Ross and William Parry were opposed, claiming that such an expedition was still premature. John Ross finally attempted a rescue in 1850–51.

In 1970, the International Astronomical Union added the name of 20th-century American astronomer Frank Elmore Ross to this feature, making it doubly commemorative. Frank Ross is noted for developing wide-field astronomical lenses in addition to his work at the Nautical Almanac Office in determining the motions of the Moon. As a staff member of the Yerkes Observatory from 1924 to 1939, he worked on a photographic atlas of the Milky Way and discovered 379 variable stars and 869 stars with large proper motions.

Also visible when the Moon is 6 days old is the crater Sabine. In 1837, Beer and Mädler honored British polar explorer Sir Edward Sabine with a crater 19 miles (30 km) in diameter. Sabine is about 4,600 feet (1,400m) deep and appears like a volcanic caldera although, in reality, it is a lava-filled impact crater. Look for a low central hill jutting up from its flat floor. Sabine lies next to a similarly sized crater named Ritter in the southwestern part of Mare Tranquillitatis.

In 1818, Edward Sabine was a member of an early British expedition led by Sir James Ross to seek the Northwest Passage.



ROSS AND SABINE lie in western Mare Tranquillitatis. To see details in Sabine, catch it near lunar sunrise (some 6 days into the lunar month) or sunset (5 days after Full Moon). FROM *CONSOLIDATED LUNAR ATLAS* (LPL/UA)

KANE is a shallow, flooded crater on the northern edge of Mare Frigoris. In a curious twist, it's the only Franklin-associated crater lying at high lunar latitudes. FROM *CONSOLIDATED LUNAR ATLAS* (LPL/UA)

He was also a member of Parry's 1819–20 expedition. In 1821, Sabine traveled the coasts of Africa and North America and into the Arctic, seeking to measure the shape of the globe by observing changes in a pendulum's period. He received the Royal Society's Copley Medal for this work. In the 1830s, Sabine, along with a team of scientists, conducted a magnetic survey of England, which led him to supervise a global magnetic study.

Shallow graves

In August 1819, Sir William Parry discovered tiny Beechey Island, off the southwestern end of Devon Island. During the winter of 1845–46, the Franklin expedition would camp there. Parry named the island for Sir William Beechey, an artist and geographer on both Franklin's 1818 polar expedition and Parry's 1819–20 expedition. Beechey Island is the resting place of the first three Franklin crew members to die — Royal Marine Pvt. William Braine, Able Seaman John Hartnell, and Petty Officer John Torrington.

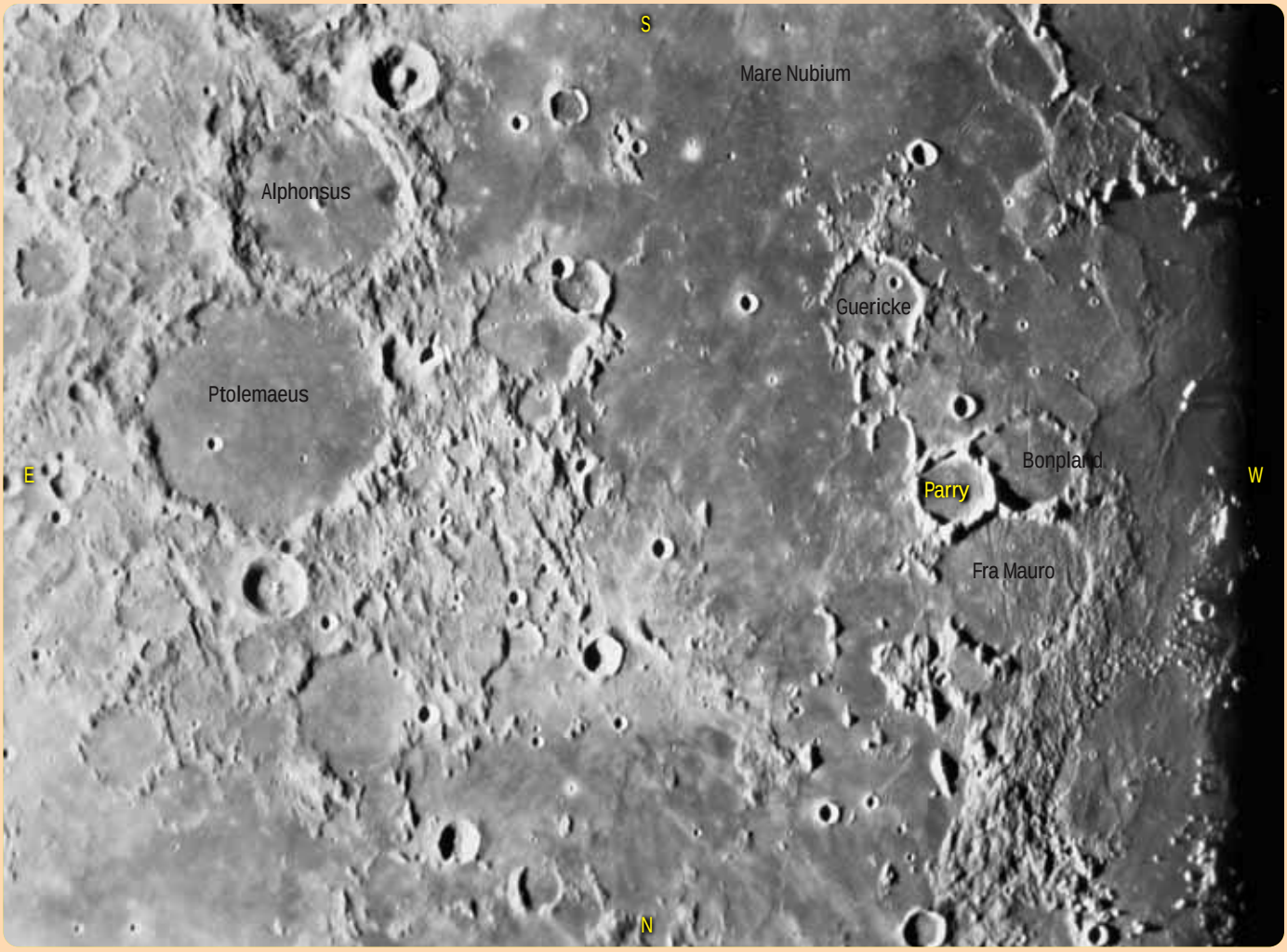
Autopsies of the exhumed bodies some 20 years ago revealed the men died of respiratory problems associated with scurvy and the debilitation of lead poisoning. The latter came from the 90/10 solder (90 percent lead and 10 percent tin) and the poor techniques used to seal the 8,000 cans carrying the crew's provisions. Except for the partial remains of Lieutenant John Irving found in the 1850s on King William Island, the Beechey Island burials are the only known Arctic graves of Franklin's men.

Returning to the Moon, the crater Kane nestles along the northeastern shore of Mare Frigoris. It was named in 1878 by German selenographer Julius Schmidt for Elisha Kent Kane, who tried to rescue the Franklin crew. Under grazing sunlight, Kane appears as a narrow, continuous, elliptical ring; under higher Sun angles, the ring appears broken along its southern portion. The crater is about 34 miles (55 km) in diameter and 3,600 feet (1,100m) deep.

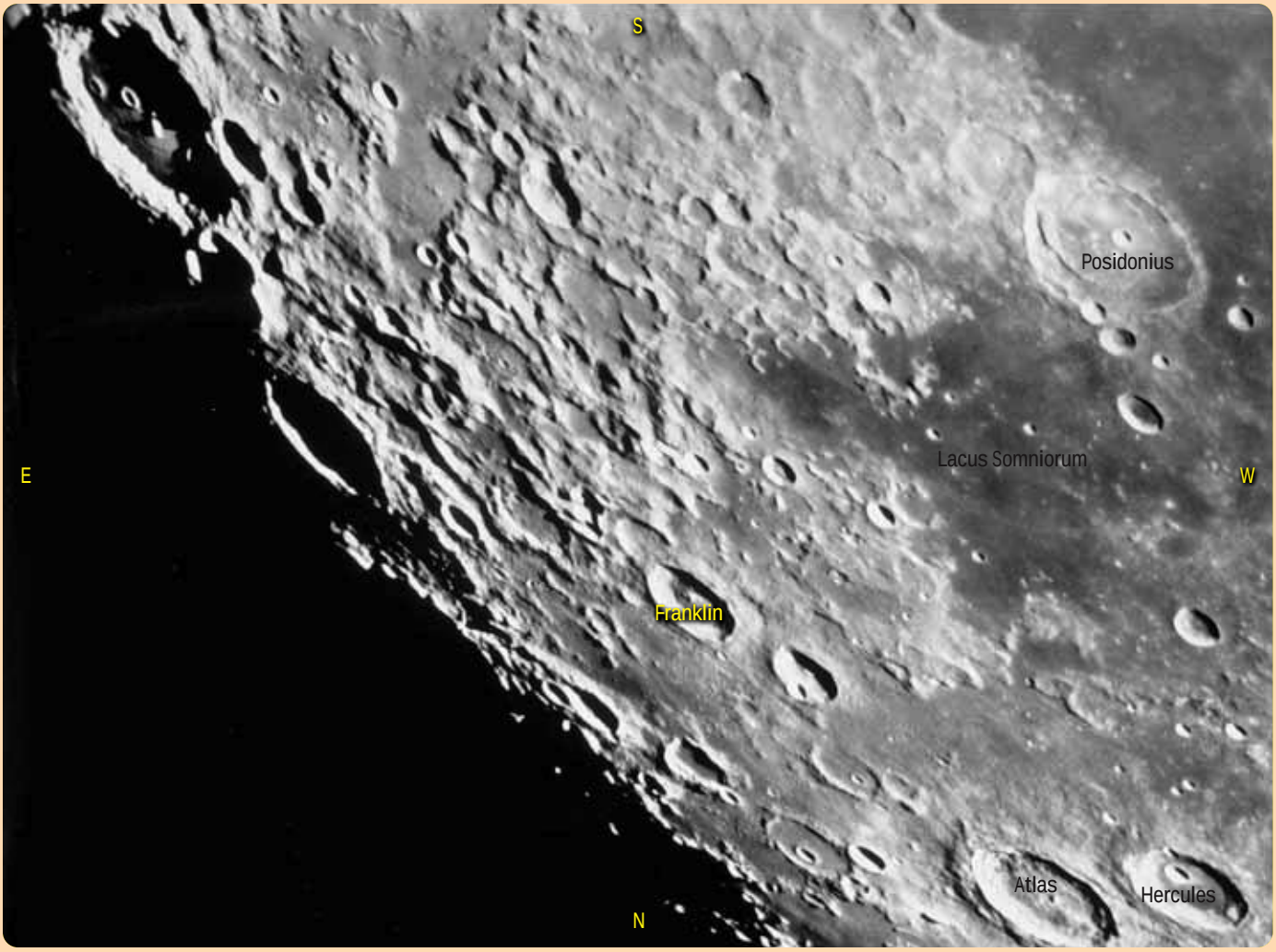
Philadelphia-born Elisha Kane received his medical degree from the University of Pennsylvania in 1842. He became an assistant surgeon in the U.S. Navy and served in China, Africa, Europe, and Mexico. From 1850 to 1851, he was the senior medical officer on the privately owned *Advance* on the first Grinnell Expedition to search for Franklin. (The expedition was named for its financial backer, American merchant Henry Grinnell.)

In August 1850, the crew of the HMS *Lady Franklin* found the Beechey Island graves. Kane was informed of the discovery and crossed the pack ice to the grave site. Kane's book, *The U.S. Grinnell Expedition in Search of Sir John Franklin*, was published in 1853.

Commanding the *Advance* from 1853 to 1855, Kane headed a second Franklin



PARRY makes a trio with two other craters, Fra Mauro and Bonpland. Flooded with lava and fractured by faults, the three reward those exploring by telescope when sunlight falls at shallow angles. FROM *CONSOLIDATED LUNAR ATLAS* (LPL/UA)



FRANKLIN becomes visible about 4 days after New Moon, while the Sun sets over it a couple of days after Full Moon. Look for tint variations in its floor materials and terraces on the side of its walls. FROM *CONSOLIDATED LUNAR ATLAS* (LPL/UA)

search expedition financed by Grinnell. In a familiar scenario, the *Advance* became locked in sea ice. With food running out, Kane and his crew abandoned the ship in May 1855. Hauling supplies and three boats some 80 miles (129 km), they finally reached open water. Eighty-three days and 1,200 miles (1,931 km) later, they arrived at the Danish town of Upernavik, Greenland.

Kane wrote about this trek in *Arctic Explorations: The Second Grinnell Expedition*, published in two volumes in 1856. He never fully recovered from the Arctic ordeal and died in Havana in February 1857. Kane crater and its three secondary craters become visible around First Quarter Moon.

On the Sea of Clouds

Beer and Mädler also honored Sir William Parry by naming a 29-mile-diameter (46 km) crater for him. On the northwestern shore of Mare Nubium, Parry, Bonpland, and Fra Mauro form a triangle of shallow, flooded craters. The group becomes visible about 10 days after New Moon.

Two rilles cut through Parry and extend beyond the crater's northern and western walls. Close to where the rilles intersect inside Parry, crater Parry E straddles Parry's rim. Running north from the crater Guericke F (southwest of the flooded crater Guericke), the flat floor of the graben-like trench of Rima Parry I can be traced over the rugged mountains and across crater Fra Mauro to end in the mountains near crater Fra Mauro G. Parry's southern wall is highly degraded and broken into separate peaks. Six bright craters can be seen on Parry's floor.

The central figure in this group of polar explorers is Sir John Franklin, but he's not the one for whom the crater Franklin is named. Instead, it commemorates American printer, patriot, and kite-flying scientist Benjamin Franklin. You will find Franklin crater, 35 miles (56 km) across and 12,500 feet (3,800m) deep, in the northeastern lunar highlands. It contains a 2,000-foot-high (610m) central peak, and its interior walls are terraced by landslides. Franklin shows best when the Moon is about 4 days old.

At one point, there was a crater named for Sir John Franklin. In 1863, when William Birt named a crater for Crozier, he named a neighboring crater for Franklin, but the International Astronomical Union later rejected the name.

Between 1847 and 1857, 39 separate expeditions traveled into the Arctic to search for the lost Franklin expedition or its traces. When you explore these rugged lunar features with your telescope, think of the hardships their namesakes endured exploring the icy polar regions of Earth. A

For links between Arctic exploration and Mars, visit www.astronomy.com/TOC

PROFILE

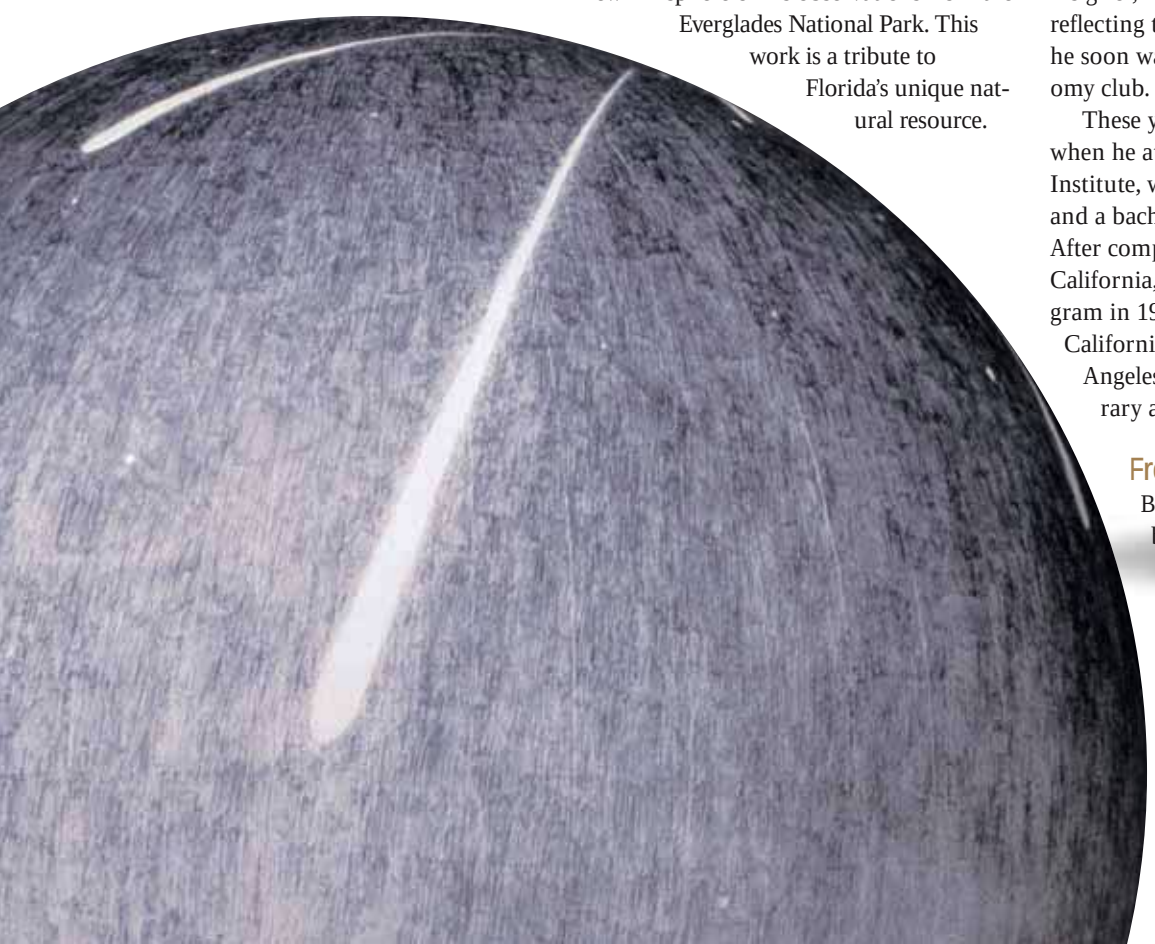
Russell Crotty turns his sketches of nightly observations into works of art.

/// HUNTER DROHOJOWSKA-PHILP

Drawing the universe

Night after night, Russell Crotty peers through the telescope in his backyard observatory in Malibu, California, making detailed observations of the Moon and planets. This 48-year-old artist is the caretaker of a 130-acre property perched on a bluff overlooking the Pacific. Leaving Los Angeles's Rampart district for the peaceful seaside meant a significant change in surroundings. "[The move] had a profound influence on the development of the work," Crotty says. Away from the light-soaked sky of L.A., Crotty renewed his childhood fascination with astronomy. Consequently, he replaced his sketches of surfers with those of celestial objects. It didn't take long for him to commit to producing astronomical art.

His work is shown at the CRG Gallery in New York City regularly and has been included in exhibits at numerous museums, most recently at the Miami Art Museum (March – June, 2004). "Russell Crotty: Globe Drawings" was his first solo show on the East Coast. He displayed nine suspended globes, varying in size from 8" to 45". The museum also commissioned him to draw a new 24" sphere of his observations from the Everglades National Park. This work is a tribute to Florida's unique natural resource.



THE LEONID METEOR SHOWER is depicted here on a paper-covered Lucite globe. RUSSELL CROTTY

Origins

Crotty's work had its beginning in his childhood. His father, Harry, was a sculptor; his mother, Jean, was a ceramist and jeweler. Crotty grew up in Northern California in a milieu of artists and poets. "I always knew I wanted to be an artist," he recalls. "My father used to give me 500 sheets of paper a month, and I would go through them doing drawings."

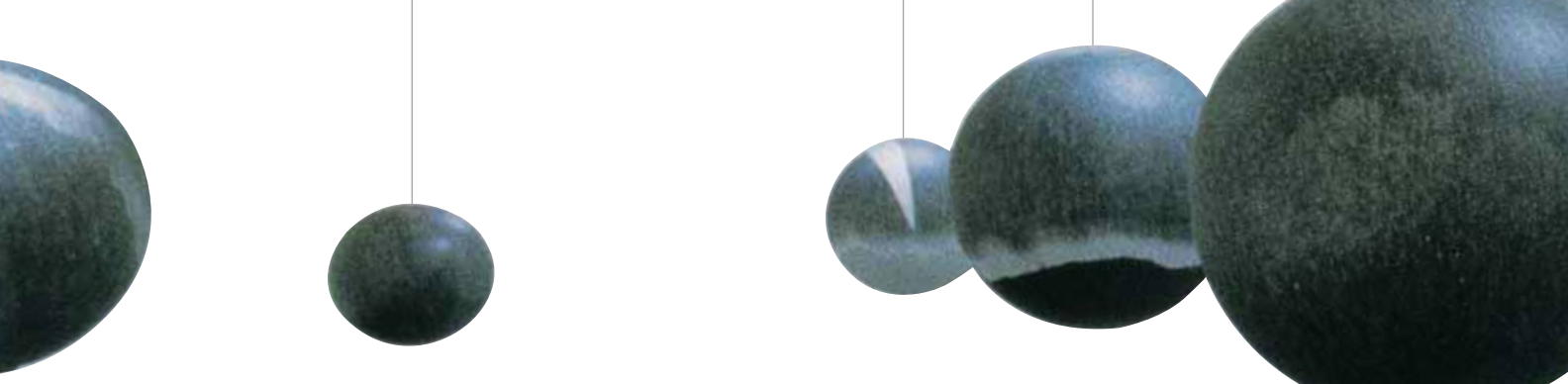
At 13, Crotty started surfing. The following year, he was diagnosed with juvenile diabetes and confined to his bed for periods of time. He escaped into his imagination by drawing cartoon-like scenarios with surfer characters and beach settings.

Around the same time, his father died of a heart attack. To distract Crotty from his grief, his mother bought him a 6-inch reflecting telescope made by Criterion, and he soon was involved in the school astronomy club.

These youthful passions were forgotten when he attended the San Francisco Art Institute, where he graduated with honors and a bachelor's degree in fine art in 1978. After completing the University of California, Irvine graduate degree program in 1980, he moved back to Northern California. In 1984, he moved to Los Angeles to join its vibrant contemporary art scene.

From surfing to stars

Between 1990 and 1993, Crotty's ballpoint pen drawings of surfers on wall-size grids gained the attention of critics. Ironically, moving to Malibu, where he could look at the coastline all day and surf



THREE-DIMENSIONAL GLOBES hang from the ceiling during a 2001 exhibit at the Art Center College of Design in Pasadena, California. The globes vary in diameter from 3 to 4 feet. COURTESY ART CENTER COLLEGE OF DESIGN

whenever he desired, dampened his drive to continue those drawings. One night, he stepped onto the front porch and looked up to see a crystal necklace of stars and planets arrayed on velvet darkness. "It was like 'Aha!'" he recalls. "I knew I could make work out of that for a long time."

Crotty was familiar with the positions and appearances of stars and planets. He could identify Jupiter in the constellation Leo by its brilliance, for instance. To construct accurate representations of the universe, the artist learned how to make scientifically accurate visual observations and detailed annotations. "It was a challenge for me, a discipline I needed," Crotty says.

Once prepared mentally, he built a corrugated metal shed about 500 feet from the house. Crotty commissioned Ed Grissom, a well-known local amateur astronomer, to build a telescope facing away from the lights of Los Angeles and toward the deep, black sky over the ocean. Solstice Peak Observatory, as Crotty calls it, cost him about $3,000 and houses his 10-inch f/8 Newtonian reflector on a proudly non-computerized, dual-axis parallax drive. Crotty also started attending star parties with fellow amateur astronomers on Mt. Pinos in the Los Padres National Forest in southwestern California, far from any city lights and perfect for stargazing.

Global matters

As the millennium approached, Crotty started drawing on paper-covered Lucite globes between 3 and 4 feet in diameter. For example, on one three-dimensional version of Earth, he renders the horizon as seen from Malibu in dark silhouette, backlit by the reflected light of the city. The skies are tethered to man-made manifestations of architecture as well as to spiky stands of pine and oak.

AFTER A DAY OF CLEARING BRUSH on the 130-acre property, hiking, climbing, or working in his studio, Russell Crotty spends the night observing the Southern California sky from his homemade, hilltop observatory. STUART GOW

Visual observation of the stars dates to the Neolithic Age, but astronomers now rely more on computers to assist with their searches of the night sky. Crotty does not depend on computers to make his observations. Instead, his knowledge and interest drive each of his four scopes — including the reflector from his childhood. He is committed to astronomy of the 19th century, when the discipline was suffused with romance and mystery. "I like being out in the cold, with my paper on a clipboard, making drawings of planets," he says. Lately, he's concentrated on observing double stars and enjoys the challenge of splitting them.

He makes straight scientific illustrations that serve as departure points for his artwork. He focuses on the circle format that gives viewers the impression of looking through the eyepiece of a telescope, a point of view that includes them in the experience of discovery.

He spends the nocturnal hours in his observatory, making painstaking drawings illuminated by a tiny flashlight held in his mouth. Back in the studio, he expands and alters these firsthand impressions. What he sees through the telescope each night, he says, is "where it all begins."

Living in Malibu, Crotty finds himself enamored of nature. "The main thing is the awe of it all," Crotty says. "The awe of looking through a telescope at the 'ancient light' of the planets. That's the phrase used by poet Kenneth Patchen. Ancient light. It's simple, but it expresses so much." A

Hunter Drohojowska-Philp *is a regular contributor to publications including* ARTnews, Artnet, Metropolitan Home, *and the* Los Angeles Times.

Confused by all the "extras" available for your scope? These 25 are the cream of the crop. /// BY MICHAEL E. BAKICH

25 great accessories

I once purchased my dream car, a convertible, after a thorough job of shopping around and looking at vehicles. However, one important thing was missing: a good sound system. A similar thing happens often when people buy telescopes. They focus on the main product and forget to check on important accessories.

What's the most important accessory for your scope? It depends on a number of factors, such as what type of telescope you own and whether the mount is a go-to model; how far away your observing site is and what its conditions are; and what level of comfort you expect while observing.

1) Paracorr

The Dobsonian revolution popularized large Newtonian reflectors. Those with short focal ratios, however, suffer from an optical defect known as coma, which causes star images (especially those near the edge of the field of view) to appear like unfocused comets.

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The solution is the "parabolic corrector," or Paracorr, manufactured by Tele Vue Optics. This optical marvel corrects coma without introducing false color or spherical aberration, another optical defect in some mirrored telescope systems. The overall effect of the Paracorr is to increase the usable field of view, which is important if you have a non-motor-driven Dob. With the Paracorr in place, you don't have to shift your scope from one part of a large celestial object to another or keep a smaller object dead center in the field of view. Instead, you can allow an object to drift through, giving yourself more time to observe it.

2) Binoculars

An often-overlooked observing accessory is quality binoculars. Nothing beats the ease of a quick, low-power view of the Milky Way, the Moon, or a star cluster. For binoculars to function well for amateur astronomy, both magnification and light throughput must be carefully selected.

With those factors in mind, I enjoy Celestron's 9x63 Ultima binoculars. 9x is plenty of magnification, and the 63 millimeter front lenses let in lots of light. The 9x63s provide a 5° field of view and weigh only 35 ounces (1 kilogram) — light enough to allow you to hold them for quite a while without fatigue.

3) Eye patch

The least expensive accessory on this list is an eye patch, available from Orion Telescopes and Binoculars. Sometimes ignored by observers, an eye patch is one of those accessories you use once and then never leave home without.

An eye patch covers your non-observing eye so it can remain open and relaxed. Having both eyes open during observing dramatically reduces eyestrain. The result? You observe longer.

4) Illuminated reticle

If you neither know what an autoguider is nor own one, you'll need an illuminated reticle eyepiece for astrophotography or CCD imaging. I recommend Meade's Series 4000 Plössl 9mm Illuminated Reticle Eyepiece. The reticle is part of a high-quality, 4-element Plössl eyepiece. The reticle pattern is a double crossline with two concentric circles, and it can be moved left-right and up-down to a desired position in the field of view. Wireless and corded variable-brightness models are available, but if you own a Meade LX200 series telescope, go for the corded model. It can be controlled from the hand paddle, minimizing vibrations to the scope.

5) Single-power finder

Single- (or unity-) power finders are real time-savers. Simply look through them at the sky, move your telescope, and lock down the telescope motions. If you've taken the time to align your finder, the object you want to observe should be in the eyepiece's field of view.

My choice of single-power finder is the Rigel QuikFinder. The QuikFinder's base occupies a small footprint on your telescope (roughly 2¼ inches [5½ centimeters] square), and it rises 5 inches (13 cm) off the tube. I find this perfect for scopes of all sizes. Another plus is the QuikFinder weighs only 3½ ounces (95 grams).

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ALL PHOTOS: ASTRONOMY/WILLIAM ZUBACK

Remember that a single-power finder is a "heads-up" display. When you look through it, you see a red bulls-eye pattern superimposed on the sky; the Rigel QuikFinder's bulls-eye circles are 2° and 0.5° in diameter. A nice feature of the QuikFinder is the ability to have it pulse at a set rate, making it easier to see faint objects.

6) Variable Filter System

Sirius Optics has developed a filter that's a lot of fun to use. Called the Variable Filter System, this 1¼" unit consists of a filter in a black anodized aluminum housing with an exposed wheel. Turning the wheel changes the filter's transmission characteristics. It can be adjusted to become a nebula, contrast, or broadband hydrogen-alpha filter. Turn the wheel slowly for maximum effect, and plan to spend a lot of time observing through this filter.

7) LaserMate

For a reflecting telescope to perform at its best, you have to align its optics. This process is called collimation, and nothing is more feared and ignored by amateur astronomers. An accessory that can simplify this process would be valuable indeed.

To this end, Orion Telescopes and Binoculars introduced the LaserMate Deluxe Laser Collimator, turning collimation into a one-step procedure. A view port in the collimator's housing lets you see both the emitted and return beams from the laser while you're at the rear of the telescope. As you adjust the collimation bolts on the mirror cell, you see the result immediately. This beats having to walk back and forth from the mirror cell to the eyepiece until you get the collimation right.

Michael E. Bakich *is an associate editor of* Astronomy.

8) Dew remover

Dew is a problem because at night, your telescope's temperature drops below what is known as the dew point. You want to keep the temperature of your scope above the dew point but not high enough to cause disturbing air currents in the tube, which ruin your view. Orion Telescopes and Binoculars sells a great accessory called the Dew-Remover Gun. It operates on 12 volts DC and plugs into a standard automobile-lighter socket. It generates 156 watts of heat and a warm air stream to bring your telescope's temperature up enough to prevent dew formation.

9) Reading light

Please, for your own safety around experienced observers, do *not* take a flashlight and wrap a piece of red cellophane around the lighted end. A bright light, even if it is red, will draw the ire of those around you. Instead, I recommend the Starlite, a flashlight by Rigel Systems. This light contains *only* two red light emitting diodes (LEDs), and it's adjustable in brightness. As you progress further into amateur astronomy, the amount of light you use for reading star charts will diminish. Brighter light means you'll see less at the scope, or that your eyes will take longer to readapt to the darkness.

10) Dew heater

If you observe from a consistently humid location, I suggest a different solution than number 8 — a dew heater. The best system I've found is the Digital Dew Heater Control Unit made by Thousand Oaks Optical. This is a microprocessor-controlled component system with a four-channel heater. Each channel adjusts fully and controls heater bands that can be wrapped around eyepieces, finder scopes, or telescopes up to 16 inches in aperture. The heater comes with a 12-foot cord and car-lighter adapter. A battery-saver feature turns the unit off if the voltage in your supply battery (usually a 12-volt automobile battery) drops below a certain level.

11) *TheSky6*

If you own a personal computer, you can go beyond the printed star atlas. *TheSky6* is the latest sky-charting software and telescope-control package from Software Bisque. A star-mapping program is a valuable accessory, and this is the best I've found. *TheSky6* displays millions of objects with startling accuracy, allows you to customize the display, generates observing lists, lets you underlay images of the real sky, and — with the help of your computer-controlled telescope — even charts your horizon profile. Several versions are available, including Student, Serious Astronomer, and Professional.

12) Powermate

Once shunned by observers, today's Barlow lenses provide high-quality views with few sacrifices. But even the finest simple Barlow lens degrades the image a bit, especially when you use eyepieces with long focal lengths or extremely wide fields of view.

A better design would incorporate more lens elements, and that's exactly what Al Nagler of Tele Vue Optics did in 1998. Called the Powermate, the four-element design provides the magnification of a Barlow lens without the limitations. Powermates are available in four magnifications, from 2x to 5x.

13) *Herald-Bobroff Astroatlas*

Does your star atlas come up short in what it displays? Mine did, so I was happy to hear that Lymax Astronomy reprinted the *Herald-Bobroff Astroatlas*. This large-scale atlas covers the entire sky with 214 easy-to-read charts. Stars are shown to magnitude 14 and deep-sky objects to magnitude 15. This atlas is also spiral-bound and lays *flat*. In addition, the atlas is printed on synthetic, moisture- and tear-resistant paper. Believe me, you'll use this accessory hundreds of times under the stars.

14) Observing chair

Only beginners overrate observing comfort. If you're at all uncomfortable at the telescope, you'll do less observing, and the observations you do make will be less fulfilling and less accurate.

Nothing says comfort like a quality observing chair. My "quality" chair has sturdy construction, a padded seat, and adjustable height. I don't like the "piano stool" type of chair because it has no back support, something this observer craves after a long night at the

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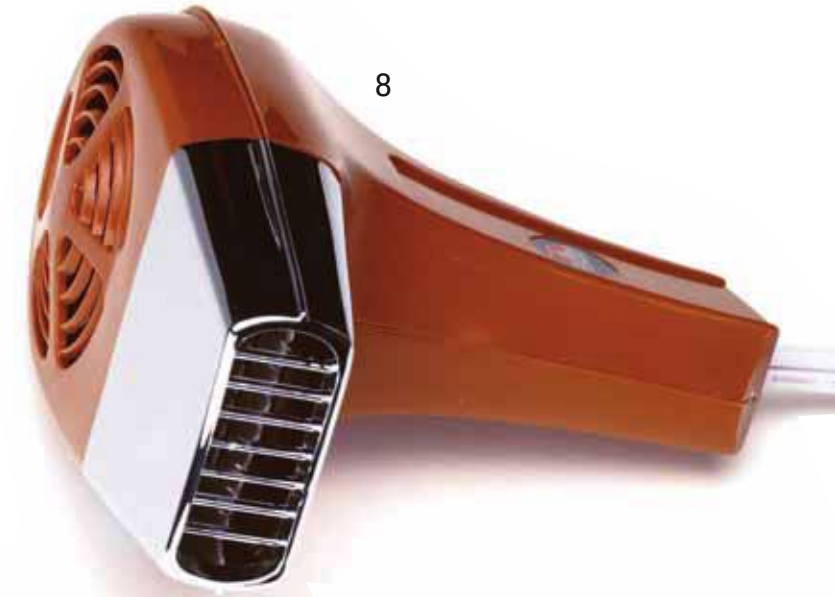

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telescope. The best chair I've used is the StarBound Observing Chair, available from many astronomy equipment dealers.

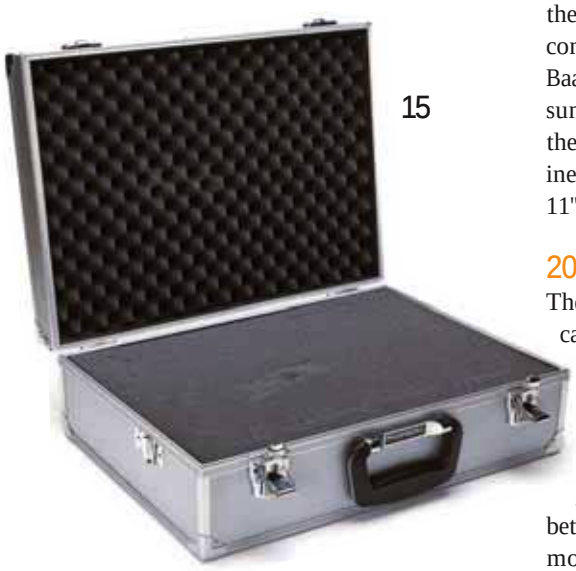
15) The Pluck-Foam case

As quality optical equipment, eyepieces and filters must be treated with care. Not doing so invites dirt, scratches, dents, or worse. To protect against these factors, most observers eventually acquire at least one foam-padded storage case.

Orion Telescopes and Binoculars makes the storage case I use — the Aluminum Pluck-Foam Accessory Case. This model is able to survive the occasional minor ding, drop, or fall with minimal damage to the case itself and no damage to the contents. I've had no trouble with dust since I started using the Pluck-Foam case. The inside is filled with precut foam cubes. Remove just enough cubes to fashion a properly shaped cove for your equipment.

16) Everbrite

It may be time to throw out your old star diagonal, especially if it employs a prism. The best star diagonals use first-surface mirrors, and the best I've found is Tele Vue's Everbrite. Tele Vue uses a non-metallic, dielectric coating that reflects 99 percent of all visible light. Each diagonal is machined from a solid block of aluminum, ensuring the Everbrite's body can't unscrew when heavy Nagler eyepieces and Powermates are inserted. Both the 1¼" and 2" models feature brass clamp rings, which prevent the barrel of the eyepiece from being scratched by direct contact with a screw.



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17) Anti-vibration pads

If your telescope and mount sit on a tripod (rather than a permanent pier), do yourself a favor and purchase a set of Celestron anti-vibration pads. The damp-down time (the time it takes an image to stabilize after the scope is touched) is reduced greatly when the pads are in place.

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18) T-ring/T-adapter

If you want to try astrophotography and have a 35mm or digital SLR with interchangeable lenses, buy both a T-ring and T-adapter. These inexpensive accessories will allow you to substitute your camera for a 1¼" eyepiece on any telescope. The T-ring is specific to your camera. On one end, a T-ring has the same protrusions (or "ears") as the base of a camera lens. On the other end, it is threaded to receive the T-adapter. The T-adapter (you'll need only one) screws into any T-ring and then attaches to a telescope the same as an eyepiece.

19) Baader AstroSolar Safety Film

One of the best investments you can make is in a high-quality visual solar filter. You immediately increase your potential observing time into daylight hours, and there's always something interesting happening on the Sun. Through the years, I've used just about every visual solar filter sold. The best of the lot is the Baader AstroSolar Safety Film. You'll have to make your own filter cell after purchasing this film, but it's worth it.

The increased brightness of the Sun through the Baader film is more than you'll see through other filters, but the details in the image are not washed out. In fact, the contrast of the solar disk through the Baader film is excellent. Features such as sunspots and faculae are seen easily through the Baader film. Also, the Baader film is inexpensive. The smallest sheet sold — 8" by 11" — costs only $20.

20) SCT Cooler

The SCT Cooler ventilates the inside of a catadioptric telescope to bring it quickly to ambient temperature. This minimizes image-ruining tube currents and heat pillars in 10 to 20 minutes instead of the usual 45 minutes to 2 hours. The greater the temperature difference between your scope and the outside air, the more quality viewing time you can reclaim with a CosmicOne SCT Cooler, invented by Lymax Astronomy's Robert Haler. An important feature of the Cooler is the micron-level filtration that eliminates contaminants from the inside of the telescope. Schmidt-Cassegrain telescopes are great performers, but they can be notorious heat collectors during the daytime. If you own one, check out the CosmicOne SCT Cooler.

21) Focuser

For some telescope systems, the weak spot is the focuser. Selecting a high-quality focuser is not trivial, but once you use one, you won't want to change.

A high-quality focuser should eliminate backlash. Backlash occurs if there is looseness, or "play," in the focusing mechanism when the direction of focus is changed. Focusers should be well-machined with no sharp edges. They should provide plenty of in-and-out travel and accommodate all your eyepieces, both 2" and 1¼". Motorized focusers should move smoothly and be variable in speed.

My choice for the best focuser is Meade Instrument Corporation's Zero Image-Shift Microfocuser. This four-speed focuser is included with all LX200GPS telescopes (controlled by the hand paddle), but it also can be used on other Meade and non-Meade SCTs. As an add-on accessory, the Zero Image-Shift Microfocuser comes with a separate hand paddle.

22) Bino Vue

Regarding price, at the upper end of observing accessories, you'll find the binocular viewer. Bino-viewers are expensive, and each needs a matched pair of eyepieces to use. If you have the resources to indulge yourself, I recommend Tele Vue Optic's Bino Vue. The color correction and sharpness of the Bino

17
18
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19
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Vue are unparalleled. Tele Vue has combined the Bino Vue with a special compensator lens system, allowing it to be used with any scope.

23) Power Tank

If you observe from only one location, and if that location has alternating-current power, consider yourself lucky. For the other 99 percent of us, some form of portable power is essential. My choice of power supply is Celestron's Power Tank 17. As the name implies, this is a 17 amp-hour, 12-volt DC power system — and a lot more. Two 12-volt sockets (input or output) are supplied. Individual 3-volt, 6-volt, and 9-volt jacks are also supplied. Other features include a red-filtered flashlight and an emergency white spotlight.

24) Time and more

You'll need a device for timekeeping if you plan to record your observations. A wristwatch is a good choice because it's always at hand, so to speak. Rather than a simple timekeeper, I opt for something a bit more exotic — and useful. My choice of observing wristwatch is the Tissot T-Touch. In addition to an analog readout for the time, the T-Touch includes an alarm, stopwatch, altimeter, thermometer, barometer, and compass. You can access the T-Touch's functions simply by touching the dial.

25) OIII filter

The OIII filter is the *great* filter of amateur astronomy. After I'd observed through many color filters, several light pollution and UHC filters, and even a hydrogen-beta filter, I settled on the Lumicon OIII as my favorite. In fact, this filter is one of my favorite accessories listed here.

The OIII is a narrow bandpass filter that transmits a range of light near the two strong spectral lines of doubly ionized oxygen (designated OIII) while blocking all other light. An OIII filter works best for emission and planetary nebulae. This filter, coupled with an 8-inch or larger telescope under a moderately light-polluted sky, will surprise you. It makes the brighter nebulae stand out. But the real joy of using this filter comes when you're at a dark site. Light from the nebula you're observing easily passes through the filter, but light from stars in the field of view is dimmed considerably. You'll find yourself reaching for your OIII filter again and again.

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Do we live on a "privileged" planet?

The Privileged Planet

Guillermo Gonzalez and Jay W. Richards, 444 pages, Regnery Publishing, Washington, D.C., 2004; ISBN 0–89526–065–4; hardcover, $27.95.

Is there life elsewhere in the universe? *The Privileged Planet* gives a new spin to the argument that conditions on Earth are essentially unique.

Authors Guillermo Gonzalez and Jay W. Richards suggest Earth was designed for scientific discovery. They introduce the "measurability" concept — the idea that Earth is ideal for scientific observation. For example, the authors argue that if the Moon were slightly larger or smaller, scientists couldn't study eclipses. Or if atmospheric conditions were different, astronomers wouldn't be able to observe stars from Earth's surface. The authors then ask what the chances are that another planet could have the same specifications necessary for conducting scientific research.

The book critiques the Copernican principle, which holds that Earth is not special in its ability to support life. The authors argue that Earth's measurability demonstrates the flaws in the Copernican principle and marks the theory's limitations as astrobiology dogma.

Yet instead of analyzing research, the book focuses on debates about the search for extraterrestrial intelligence (SETI), specifically the Drake equation. The book also dwells on numerous philosophical statements by Carl Sagan. But because SETI now extends to planetary evolution and prebiotic molecular chemistry, the authors' criticisms paint a misleading view of the subject. More analyses of peer-reviewed studies and less criticism of philosophical statements would be better.

The book's second limitation is its circular-reasoning tendency. The authors repeatedly argue that a system's components would not be as measurable if the system itself were entirely different.

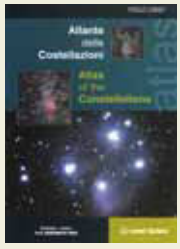
For example, one chapter explains that, since earthquakes exist, scientists can measure and learn more about them. However, planets without similar quakes wouldn't provide scientists with as much information about plate tectonics, the structure of planetary mantles, or related geological phenomena; and so on.

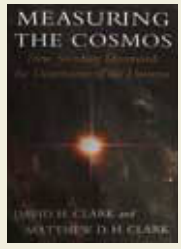
But while we've learned much about the solar system, we know very little about planets outside the solar system. Thus it's reckless speculation to claim natural systems on other planets would pose insurmountable barriers to any inhabitants making scientific discoveries.

Despite these criticisms, the authors' argument does move forward one side of the origin-of-life debate. Because the topic of extraterrestrial life elicits extreme responses across the board, the authors' general skepticism is useful.

The authors' ability to juggle research perspectives from many different fields is also impressive. Each chapter presents thought-provoking examples of astronomical, geological, and biological systems, and then demonstrates how scientific observation is possible due to the conditions that make Earth habitable.

This ambitious, multidisciplinary approach paints an inspiring portrait of the delicate balance needed to sustain life. At the very least, the book's poetic praise of Earth's pristine measurability will leave readers much to ponder. — AMY COOMBS *is a research technician in a biophysics lab; her science features have aired on National Public Radio.*





Atlas of the Constellations

Paolo Candy, 189 pages, Travel Factory, Rome, 2004; ISBN 88–87155–19–4; paperback, 38 euros ($46 approximately). [w] www.travelfactory.it/cat_cultura.htm

This is a beautiful photographic star atlas that presents the sky down to about –40° declination in 43 plates. (One plate centered on Crux goes to –75°.) The atlas also shows prominent asterisms and the classical constellation figures from mythology. Major stars, Messier objects, and a few bright NGC objects are labeled.

Measuring the Cosmos

David H. Clark and Matthew D. H. Clark, 203 pages, Rutgers University Press, New Brunswick, New Jersey, 2004; ISBN 0–8135–3404–6; hardcover, $22.95.

How distant are the stars? This question has challenged astronomers for ages, but the first accurate stellar distance measurement (for 61 Cygni) wasn't achieved until 1837. The Clarks, father and son, begin their story with the ancient Greeks and continue to today's cosmologists, who are probing the limits of knowledge and the universe alike in their quest to measure the cosmos.

Building Moonships

Joshua Stoff, 128 pages, Arcadia Publishing, Portsmouth, New Hampshire, 2004; ISBN 0–7385–3586–9; paperback, $19.99.

Using almost nothing but photos and captions, aerospace historian Stoff tells the story of how Grumman Corp. built the Apollo lunar landers. Many of the photographs have never been published.

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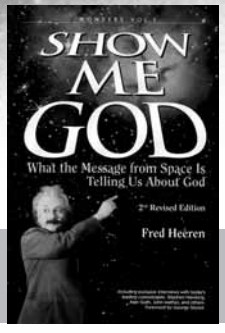

Show Me God **– 2004 Revised Edition**
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astronomics . . . our 26th year.

Selling you the right telescope means listening carefully to what *you* want to see and do with a telescope – to match your needs and dreams to your budget. It means answering your questions truthfully and fully. It means taking the time to explain your options. It means using our more than 160 years of experience in using and selling telescopes to make sure that you get the scope and accessories that work together properly and do what you want to do . . . the scope and accessories that are right for *you.*

We've been helping people choose the right telescope since 1979. We have the experience to help *you* pick the scope that fits your needs (and your budget) from the hundreds of telescopes we stock. And, with our seven-figure inventory, we can usually ship you the right scope right away.

We started ***astronomics*** over 25 years ago because we loved astronomy, not just as a business. Our sales may have grown over a thousand-fold since that first year, but we're still the same family-owned, family-run, full-line telescope dealer we were in 1979. And we still love astronomy.

astronomics. No hard sell. No guesswork. Just honest advice, the time to make sure you get the right telescope and accessories, and a good price. Call us toll free at (800) 422-7876 and find out for yourself.

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astronomics has been a Meade dealer since 1980. We have been a Meade Advanced Products Dealer – one of an elite group of astronomical specialists – since the program was established in 1992. And now we've been named one of a very select group of ***Meade Elite Dealers*** in recognition of our continuing commitment to giving *you* the most reliable advice, the widest in-stock equipment selection, and the best service – both before and after the sale.

We ship Meade LX200GPS go-to scopes from *our* stock.

Meade 8" LX200 GPS SMT **$2195**

You can get the Meade telescope you want shipped from our stock . . . right now . . . at the right price . . . right here at ***astronomics.*** **Meade LX200GPS** scopes have a GPS system to align your scope on the sky *automatically.* You'll be observing in minutes.

Their Autostar computers can find and track over 145,000 stars and objects for you *automatically.* You spend more of your time looking *at* heavenly bodies and less time looking *for* them.

Smart Mount Technology improves your scope's pointing accuracy as you observe. A Lunar Planetary Imager takes digital color pictures for you. Optional UHTC optics increase light transmission by up to 20% – so you see up to 20% more of the Universe.

Here are the Meade LX200GPS telescopes that we ship from our stock:

7" Maksutov-Cassegrain	**$2695**^{00}
7" Maksutov-Cassegrain, w/UHTC	**2845**^{00}
8" Schmidt-Cassegrain	**2195**^{00}
8" Schmidt-Cassegrain, w/UHTC	**2370**^{00}
10" Schmidt-Cassegrain	**2745**^{00}
10" Schmidt-Cassegrain, w/UHTC	**2980**^{00}

Here are the LX200GPS telescopes Meade ships from the factory due to their weight:

12" Schmidt-Cassegrain	**$3595**^{00}
12" Schmidt-Cassegrain, w/UHTC	**3890**^{00}
14" Schmidt-Cassegrain	**4995**^{00}
14" Schmidt-Cassegrain, w/UHTC	**5345**^{00}
16" SCT, w/altazimuth pier and UHTC	**15,645**^{00}
16" SCT, w/equatorial pier and UHTC	**15,845**^{00}

Factory-authorized TeleVue eyepiece and filter sale.

Through December 31st, you'll save up to $90 on a **TeleVue Nagler** or **Radian** eyepiece. You can also save up to $45 on a **TeleVue Bandmate** light pollution filter. Here are the prices on the premium TeleVue eyepieces and filters we can ship to you today .

Radian, 3, 4, 5, 6, 8, 10, 12, 14, or 18mm	**$199**^{95}
Nagler, 2.5, 3.5, 5, 7, 9, 11, or 13mm 1.25"	**240**^{00}
Nagler, 2mm to 4mm zoom 1.25"	**340**^{00}
Nagler, 3mm to 6mm zoom 1.25"	**320**^{00}
Nagler, 12mm 1.25" and 2"	**300**^{00}
Nagler, 16mm 1.25"	**270**^{00}
Nagler, 17mm 2"	**330**^{00}
Nagler, 20mm 2"	**370**^{00}
Nagler, 22mm 2"	**$390**^{00}
Nagler, 26mm 2"	**490**^{00}
Nagler, 31mm 2"	**530**^{00}
1.25" Oxygen III, line band filter	**99**^{95}
2" Oxygen III, line band filter	**169**^{95}
1.25" Nebustar, UHC-type narrowband filter	**99**^{95}
2" Nebustar, UHC-type narrowband filter	**169**^{95}

> Thanks again for the great service and helpful advice on my telescope purchase. You are, by far, the most informative and helpful folks out there in the retail telescope market. (I know, I really shopped everyone I could find before buying.)
>
> **Customer Quote of the Month #153**

Meade LXD75 go-to scopes make astronomy easy.

6" Meade SN-6 AT Schmidt-Newtonian **$799**

Even if you don't know the skies, you won't spend all your time hunting for deep space wonders with a go-to **Meade LXD75** reflector, refractor, or Schmidt-Cassegrain.

A few touches on your scope's Autostar computer speeds you to any of 30,000+ stars and objects and tracks it accurately for as long as you want to observe. You spend more of your time looking *at* celestial objects and less time looking *for* them with a Meade LXD75.

Each has an adjustable height steel leg tripod, dual motor drive, finderscope, eyepiece, illuminated polar finder, Autostar computer to take the guesswork out of finding your way around the skies, and a Lunar Planetary Imager digital camera.

8" Meade SC-8 AT Schmidt-Cassegrain **$1299**

We have new extended shopping hours at *astronomics* . . .

For your convenience, we've extended our telephone hours until 9 PM CST Monday through Friday. You can call late and still get the friendly, reliable Astronomics service you've come to rely on for more than 25 years. Our regular telescope experts will be available to answer your questions, not just an order taker – so you can call us late for all your telescope needs!

Everyone can afford CCD when cameras start at $249!

SAC Imaging CCD cameras make electronic photography affordable. Even owners of small telescopes, like the Meade ETX-90, can do serious CCD imaging with a sensibly-priced SAC camera.

SAC7B cooled 24-bit color **$499**

Whether you take short lunar and planetary shots, long exposure deep space photos, black and white, single-pass full color, or tri-color with a filter wheel – there's an inexpensive SAC camera to do it.

Our **www.astronomics.com** website has full details and pricing.

Tectron tools make collimating easy!

Tectron collimating tools will get the most out of your Dobsonian or Schmidt-Newtonian optics. The $43 Cheshire tool, left, will have your reflector performing like a million bucks! No self-respecting reflector should be without one. Buy it alone or in a set that includes an autocollimator and sight tube.

Celestron Dobs are nifty, inexpensive, *and in stock.*

Celestron StarHopper Dobsonians are loaded with useful features. Instead of Teflon or plastic pads sliding on Formica to support the scopes, roller bearings with dozens of support points ride on a broad azimuth track for a smooth hitch-free horizontal motion. The altitude bearings ride on nylon rollers for an equally smooth vertical motion.

8" f/6 StarHopper **$349**

A variable tension altitude clutch compensates for different eyepiece weights. The finderscopes (a 6 x 30mm on the 6" and a 9 x 50mm on the 8", 10", and 12") are mounted in easy-to-align quick release brackets. The 8", 10", and 12" scopes have a 2" metal rack and pinion focuser (with a 1.25" eyepiece adapter) and come with a 2" 32mm E-Lux eyepiece. The 6" scope has a 1.25" metal rack and pinion focuser and a 25mm 1.25" Plössl.

The 10" and 12" scopes have a battery-operated fan for cooling their primary mirrors. All have fast cool-down metal tubes and BK7 optical glass mirrors.

Here are the prices for the fully-equipped Celestron StarHopper Dobsonians.

6" f/8 StarHopper	**$249**^{00} + $49 freight
8" f/6 StarHopper	**349**^{00} + $59 freight
10" f/5 StarHopper	**499**^{00} + $69 freight
12" f/5 StarHopper	**849**^{00} + $99 freight

Want to read unbiased equipment reviews by amateur astronomers just like you? See the equipment review site at www.cloudynights.com

Why wait for another dealer to *order* your scope? We'll ship your Meade LX90 from our stock *now.*

$1695

Some dealers don't even stock the telescopes they sell. *We do.* So why wait for one of those no-stock dealers to order an LX90 for you when we have them ready to ship? You can get your LX90 from us right away.

The **Meade LX90** Schmidt-Cassegrain lets you enjoy 8" go-to astronomy for not a lot of money. It costs only $1695. For that price you get a heavy-duty adjustable height tripod; 26mm Super Plössl eyepiece; Autostar computer with 30,223 stars, planets, and deep space objects it can find and track for you; a big 8 x 50mm finderscope; and more. It's a lot of go-to telescope at a very reasonable price.

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Here's a tasty smorgasbord of observing aids that are sure to please any astronomer. Give one or more to your favorite observer or leave a copy of this ad on the kitchen table with the items *you* hunger for this year neatly circled in red. Santa is bound to notice your subtle hint.

Gifts under $50 . . .

Eyepiece cases start at only $2.49. Our bolt-type plastic containers keep your eyepieces free from dew and dust. Foam inserts cradle eyepieces to protect against accidents. **www.astronomics.com** lists which eyepieces fit which containers.

Observing books at half price or less.

Galaxies & The Universe: This 112-page soft cover helps you find hundreds of galaxies. Our part #A9573. Regularly $19.95, it's sale priced at only **$7.95**.

Stars & Galaxies: Our part #A9566. This 200-page hard cover includes 344 of the best deep sky objects. Regularly $29.95, it's sale priced at only **$9.95**.

Universe From Your Backyard: This 188-page hard cover, #9565, helps you find 690 of the finest deep space objects. Regularly $29.95, it's on sale for only **$14.95**.

LED flashlights start at only $21.95. Red LED night vision flashlights protect your dark-adapted vision while you're observing. The **Celestron** variable brightness flashlight (our part #VLED) is **$21.95**. The **Rigel Systems** variable brightness light (#4591), right, is **$24.95**. The **Rigel Systems** two-color variable brightness flashlight (#4592) – a red light for reading star charts, and blue-white for setting up and taking down your scope – is **$29.95**.

The best CCD book is $49.95. Before you spend $3000 on a CCD camera (or even $249), spend **$49.95** on this informative book.

The New CCD Astronomy by Ron Wodaski is the best and most complete imaging reference available for CCD photographers of all skill levels. It includes everything you need to know to become proficient at CCD imaging, plus a free subscription to on-line updates and reference materials.

Vibration suppression pads stop your scope's jitters. Put these handy pads under the legs of your telescope or spotting scope tripod and you'll virtually end the tremors that blur your view for a few seconds each time a breeze comes up or you touch the scope to focus. A set of three **Celestron** vibration suppression pads, our part #VSP, costs **$49.50.** The set of three **Meade** vibration isolation pads shown right, our part #895, costs **$49.95.** Both sets dramatically improve your observing and are well worth the modest investment.

Gifts from $50 to $100 . . .

Power to the people! Buy one Power Tank instead of hundreds of batteries. **Celestron Power Tank** high capacity rechargeable batteries have the power you need to run your telescope and accessories all night long, and can be recharged hundreds of times. That will save you hundreds of dollars over the cost of constantly buying flashlight batteries every few weeks. Each has *two* 12V DC cigarette lighter outputs; 3, 6, and 9V DC outputs for accessories; an emergency spotlight; built-in recharger; shoulder strap; carry handle; and more. The 7 amp hour Power Tank shown, our part #4512V, is only **$59.95**. The 17 amp hour Power Tank, our #4517V, is sale priced at only **$89.95**.

Gifts from $100 to $200 . . .

The sky is yours for $129! Actually, it's the **TheSky6** ***Serious Astronomer Edition*** from **Software Bisque**, It's the latest version of the most popular star-charting software around. With over 20 million stars and over a million deep space objects, it generates the most realistic and detailed graphical rendition of the night sky ever. It looks so real you'll think you're under the stars themselves.

Get more. Pay less. How much would you pay for a 1/10th wave accuracy 97% reflectivity 2" enhanced aluminum mirror star diagonal and a 1.25" eyepiece adapter? Some competitors charge up to $250 for that combination. But the **William Optics** 2" diagonal, our part #W2, is only **$130**!

The **William Optics** 2" rotatable Schmidt-Cassegrain zero image shift Crayford-style manual focuser with 1.25" eyepiece adapter below, our part #WSCTF, is only **$149**. As with all William Optics scopes and accessories, it offers exceptional value – fine optical performance and quality mechanics, at a price that's less than the competition.

Why look at a map when you can look at the sky? When skies are cloudy, you can spend your next evening's observing with the help of a star chart – or you can use **The Desktop Universe** from **Main Sequence Software**. This **$199.95** software program was named the leading Hot New Product by *Sky & Telescope* magazine. While it has all the standard star-charting features of a state-of-the-art planetarium program, it plots your charts on a seamless all-sky photographic CCD mosaic of nearly 20,000 images. You don't see lines and symbols on a blank page. You see the actual sky itself. *Sky & Tel* suggested, "It just might be the biggest advance in portraying the night sky since the paintings on the ceilings of Egyptian tombs."

This month's hot new product #1 . . . Meade Deep Sky Imager (DSI) for $299.

The Meade DSI includes an electronic camera that takes long exposure deep sky photos in full 16-bit color at a fraction the cost of a CCD camera. Anyone can take stunning deep sky photos of galaxies, nebulas, and star clusters on their first night out (as well as sharp solar system shots). It works with any telescope.

The Meade Deep Sky Imager includes the renowned Autostar Software Suite planetarium/imaging program and USB cables to connect the imager to your laptop or PC. Best of all, the entire package is all yours for only $299!

Only $995 for a 5" GPS-ready go-to Celestron. And only $1379 for an 8".

The **Celestron NexStar 5i** is the *only* 5" go-to scope with a GPS satellite alignment system available as an option. Standard equipment includes a NexStar computer control, adjustable height tripod, finder, eyepiece – everything you need to start observing tonight! Multicoated optics are *standard,* not an optional extra. NASA uses Celestron 5" optics on the Space Shuttle. Don't you deserve the same image quality?

The larger **Celestron NexStar 8i** has an 8" optical tube for two and a half times the light-gathering of the 5i, at a cost of only $1379.

$995

the Nexstar 5i is shown with optional photography accessories

and a new and improved website at www.astronomics.com!

We've added more products and features to our website. There are calculators – for CCD cameras, eyepieces, Barlows, camera adapters, and more. You can do side-by-side product comparisons. Looking for a particular product? Our site tells you if it's in stock and if we have a used one to save you money. And there are more expanded website features in store for you.

Celestron 11" scopes start at only $1699.

An 11" Celestron **Advanced Series** Schmidt-Cassegrain makes big aperture astronomy affordable. With almost twice the light-gathering of an 8" scope, it shows you more deep space objects than an 8" fork mount – *for about the same price.*

Celestron 11" scopes put multicoated optics on easy-to-use equatorial and computerized go-to mounts. The scopes available from our stock include:

C11S on an equatorial mount **$1699.00**
C11S with XLT coatings **1979.00**
C11S-GT go-to equatorial **1999.00**
C11S-GT go-to with XLT coatings **2279.00**

The C11S and C11S (XLT) have an adjustable height tripod with 2" steel legs, slow motion controls, setting circles, 40mm Plössl eyepiece, and a 9 x 50mm finder. Starbright multicoatings are standard on the C11S. State-of-the-art Starbright XLT multicoatings on the C11S (XLT) give you 16% more light. An optional dual-axis drive is available to motorize each scope.

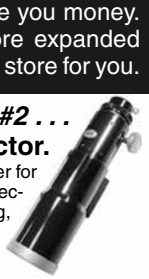
11" Celestron C11S

The GT (go-to) models add dual motor drives and a NexStar computer to automatically find over 45,000 stars and objects for you.

They are easy to transport and set up (the heaviest piece weighs only 29 lbs.) And, best of all, they're remarkably affordable. Big optics no longer cost a fortune, thanks to Celestron.

This month's hot new product #2 . . . the $250 William Optics 66mm refractor.

The **William Optics Megrez 66** f/6.5 66mm achromatic doublet optical tube has a 2" focuser, but also accepts accessories that thread onto a Schmidt-Cassegrain rear cell – 2" diagonals, T-adapters, etc.



It makes a super finder for your main scope, or a second scope for travelling, birding, and spur-of-the-moment astronomy.

Is this your last chance to save on a Takahashi apo?

To be honest, we don't know how much longer Takahashi can keep running the sale on their superb **Takahashi** *fluorite doublet apochromatic* refractors. We suspect it may all be over at the end of the year. This may be your last chance to save a bundle on a Tak apo optical tube.

FSQ-106N optical tube, **$3475**.

EM-10 mount and tripod, **$2789**.

The outstanding 3.1" **FS-78** f/8 doublet is on sale at **$1195!** You save $184!

The compact 90mm f/5.6 **Sky 90 II** is on sale at **$2065!** You save $414! *Sky & Telescope* called it "an ideal travelscope for mobile observers, providing maximum performance at minimum size."

The latest 4" **FS-102 II** f/8 doublet with sliding dew shield is **only $2095**! You save $454!

Only $4495 lets you own an **FS-128** 5" f/8 doublet! This sale saves you $754!

Finally, the 6" f/8 **FS-152** is **only $6995**! You save $2334!

We also stock the 22" long **FSQ-106N** 4" f/5 four-lens *dual fluorite* astrograph apo with a 4" focuser, shown to the left.

If you want a premium fluorite apo refractor at a money-saving sale price, and you want it right now, the scope you want is a Takahashi apo from ***astronomics***.

This month's hot new product #3 . . . Celestron NexImage $99 solar system imager.

There's a true CCD at the heart of Celestron's NexImage Solar System Imager. It's a Sony HAD full color CCD with 640 x 480 5.4 micron pixels. It takes high power lunar/planetary images with any brand and size telescope and sends them to your computer to view live or print out later. At only $99, it makes serious solar system imaging affordable for everyone.

24-Hour FAX line: (405) 447-3337 Our e-mail address: questions@astronomics.com
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NEXT MONTH

Year in review
The smallest exoplanets yet, past water on Mars, a comet flyby, and more — *Astronomy* recaps the year's top stories.

Small planets found
Astronomers have discovered two small planets orbiting normal stars. They could be ice-giant planets or rocky super-Earths — the first seen outside our solar system.

The Pleiades
The star cluster known as M45 has captivated humans' imaginations throughout history. But figuring out what's going on in this region of space takes precise science.

Driving force
Anne Kinney is one of the most powerful people at NASA whom you've never heard of ... until now.

Club-run observatories
Three observatories operated by astronomy clubs service their club members and community.

Orion IntelliScope
Two things set this instrument apart from others: It's a 10-inch telescope that sells for less than $700, and it's a Dobsonian-mounted scope to which you can add a computerized object locator.

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Astronomy.com

03.04.05–03.12.05

Astronomy and Specialty Tours

invite you to Alaska's interior for the 2005 Northern Lights Tour. This is your chance to join other aurora fanatics and watch the brilliant curtains shine. The journey begins in Fairbanks, home of the world-famous Ice Festival, with a

THE GLOWING CURTAINS of the aurora blanket the sky above Chena Hot Springs, Alaska. MARVIN NAUMAN

group banquet and a lecture from noted aurora expert Neil Brown.

The trip continues with four nights in Chena Hot Springs, an hour from Fairbanks, where dark skies prevail. During the day, guests may try cross-country skiing, dogsledding, sleigh rides, or a dip in the hot springs. After the Sun sets, the real show begins. With expectations of high solar activity, the nightly aurora show should be amazing.

Chena will be followed by three more nights in Fairbanks, with time to shop, ski, enjoy the local flavor, and observe more aurorae.

Astronomy associate editor Frank Reddy will accompany the group, lead aurora viewing, answer questions, and point out other gems of the night sky.

For more information, call Specialty Tours at 800.677.9412 (U.S. only) or 727.796.7555; fax, 727.797.1477; e-mail, steves@a1specialtytours.com; web site, *www.a1specialtytours.com*.

THROUGH MAY 2005

Solar Fireworks

Newark Museum, Newark, New Jersey. Designed by astronomers at the Newark Museum and the New Jersey Institute of Technology, this exhibit features hands-on activities and information on the Sun's composition. For more information, visit *newarkmuseum.org/planetarium*.

12.03.04

Far Out Friday

Adler Planetarium and Astronomy Museum, Chicago. On the first Friday of every month, the Adler hosts an evening of astronomy-related fun, including observing, lectures, and tours of the facilities. For more information, visit *www.adlerplanetarium.org*.

12.13.04–12.17.04

American Geophysical Union Fall Meeting

San Francisco. This meeting is an

occasion for researchers, teachers, and students to discuss all areas of geophysical science. For more information, call 800.966.2481, ext. 333; web site, *www.agu.org*.

12.13.04–12.17.04

Texas Symposium on Relativistic Astrophysics

Stanford University, Palo Alto, California. This meeting will examine cosmology and high-energy astrophysics, concentrating on the frontiers between these areas, gravitation, and particle physics. For more information, visit *texasatstanford.slac.stanford.edu*.

01.09.05–01.13.05

American Association of Physics Teachers Winter Meeting

Albuquerque, New Mexico. Held in conjunction with a meeting of the National Society of Hispanic Physicists, this event will feature many workshops, ranging from studying radio astronomy to teaching cosmology. For more information, visit *aapt.org*.

01.09.05–01.13.05

American Astronomical Society Meeting

San Diego. This gathering will include lectures, workshops, and special events. *Astronomy* senior editor Robert Burnham will attend. For more information, visit *www.aas.org*.

01.13.05

Connacht Star Party

Westwoodhouse Hotel, Galway City, Ireland. Hosted by the Galway Astronomy Club, this year's theme is "Exoplanets." The star party will feature prominent speakers from Ireland and the United Kingdom. For more information, visit *www.galwayastronomyclub.ie.*

02.07.05–02.12.05

Winter Star Party

Camp Wesumkee, West Summerland Key, Florida. Sponsored by the Southern Cross Astronomical Society. The 12-hour observing sessions at this dark-sky site will provide ample time to target celestial beauties. *Astronomy* assistant editor Matt Quandt will attend. For more information, visit *www.scas.org*.

02.09.05–02.13.05

Orange Blossom Special Star Party

Alafia River State Park, Lithia, Florida. The new site has been entirely reserved for star-party attendees. Register before December 31 to avoid a late fee. For more information, call 813.792.0721; e-mail, dnefarr@msn.com; web site, *home1.gte.net/hoffmanc*.

02.17.05–02.21.05

American Association for the Advancement of Science Annual Meeting

Washington, D.C. The theme of this year's gathering is "The Nexus: Where Science Meets Society." The conference will cover all disciplines of science. For more information, visit *www.aaas.org*.

03.13.05–03.15.05

South Pacific Star Party

Wiruna, near Ilford, New South Wales, Australia. Hosted by the Astronomical Society of New South Wales, this site offers great dark skies. The location is a nature-lover's paradise, featuring many species of exotic birds, wombats, kangaroos, and other wildlife. For more information, visit *www.asnsw.com/spsp*.

05.01.05–05.08.05

Texas Star Party

Prude Ranch, near Fort Davis, Texas. While the party is months away, the deadline to enter the registration lottery is January 17. For more information, visit *www.texasstarparty.org*.

CONTACT INFORMATION

Please submit club announcements 4 months in advance to Coming Events, *Astronomy*, P. O. Box 1612, Waukesha, WI 53187, or jmcgovern@astronomy.com. Also use this e-mail address to submit your events for our on-line calendar.

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RESOURCES

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KILLER IMPACT

BOOKS — The dangers of a near-Earth object (NEO) impact are covered best in a decade-old compendium that's 1,300 pages long: *Hazards Due to Comets & Asteroids*, edited by Tom Gehrels (University of Arizona Press, Tucson, 1994). Also take a look at Duncan Steel's *Rogue Asteroids and Doomsday Comets* (Wiley and Sons, New York, 1995). *Comet and Asteroid Impact Hazards on a Populated Earth* by John S. Lewis (Academic Press, San Diego, 2000) focuses on computer modeling of impacts.
WEB — A good place to start looking for NEOs on-line is at NASA's NEO Program Office, located at the Jet Propulsion Laboratory, *neo.jpl.nasa.gov*. For the original Spaceguard Report, see *impact.arc.nasa.gov*; click "Government Studies," then "NASA Studies."

THE GOLDEN AGE OF STAR MAPS

BOOKS — A detailed look at dozens of celestial charts created in the 16th, 17th, and 18th centuries can be found in *The Sky Explored: Celestial Cartography, 1500–1800* by Deborah Jean Warner (Wiley-Liss Books, New York, 1979). Another beautiful book is *The Glorious Constellations: History and Mythology* by Giuseppe Maria Sesti (Harry N. Abrams, Inc., New York, 1991).
WEB — Tour antique star maps courtesy of the Linda Hall Library, located at the University of Missouri-Kansas City. An exhibit titled "Out of this World: The Golden Age of the Celestial Atlas," is located at *www.lindahall.org/events_exhib/exhibit/ex_atlas.shtml*.

ASTROLOGY: FACT OR FICTION?

BOOKS — *Cosmic Perspectives*, edited by S. K. Biswas et al. (Cambridge University Press, New York, 1989), includes a refutation of astrology titled "Astrology and science: An examination of the evidence." A more direct assault is taken in Lawrence E. Jerome's *Astrology Disproved* (Prometheus Books, Amherst, New York, 1977).
ARTICLE — Director of the Astronomical Society of the Pacific's (ASP) Project ASTRO, Andrew Fraknoi authored a clear response to an Ask Astro question, "What is the difference between astrology and astronomy?" (*Astronomy*, January 1999).
WEB — Evidence on astrology's ineffectiveness abounds on the Internet. One site committed to debunking astrology is *www.astrology-and-science.com*. The ASP's Andrew Fraknoi provides an "Astrology Defense Kit," including questions to ask believers, at *www.astrosociety.org/education/astro/act3/astrology3*.

ASK ASTRO

BOOK — *The Five Ages of the Universe* by Fred C. Adams and Gregory Laughlin (Free Press, New York, 2000) describes the future universe after the stars have stopped shining and only white dwarfs, neutron stars, and black holes remain.
WEB — David Harper and Lynne Marie Stockman provide additional information about Blue Moons, including a calculator, at *www.obliquity.com/astro/bluemoon.html*.

POLAR MOON

BOOK — A fascinating work on the examination of the Beechey Island graves is *Frozen in Time: Unlocking the Secrets of the Franklin Expedition* by Owen Beattie and John Geiger (Dutton, New York, 1987).
WEB — Russell Potter of Rhode Island College compiled a detailed web site with links to the Franklin story and Arctic exploration in general at *www.ric.edu/rpotter/SJFranklin.html*. For Amanda Hall's essay on what poorly made provisions did to the Franklin crew's health, see "The Franklin Expedition: What really happened?" at *www.mysteriesofcanada.com*.

DRAWING THE UNIVERSE

WEB — Learn more about Russell Crotty's career and see images of his artwork at *www.crggallery.com/artist_pages/crotty_russell/crotty_russell.htm*.

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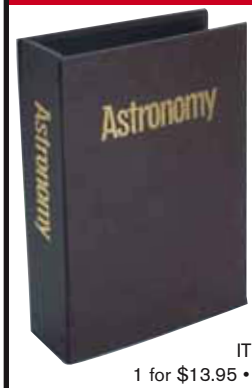

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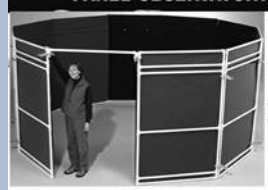
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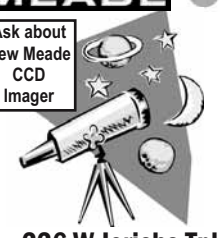

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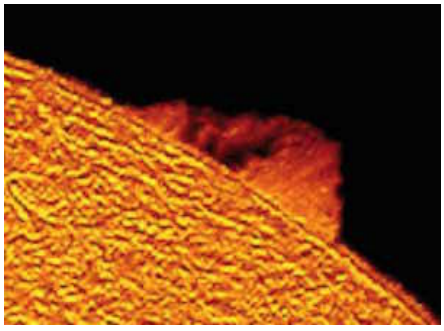
A lunar sea /// Planetary nebula /// The California Nebula /// Spiral galaxy

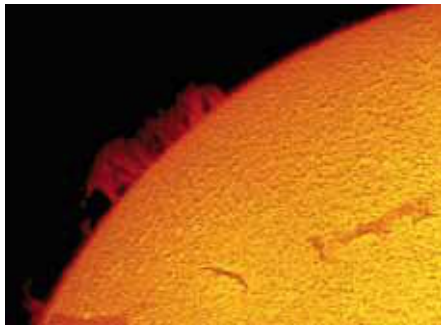
BRIGHT NEBULA AND STAR CLUSTER IN A SOUTHERN CONSTELLATION

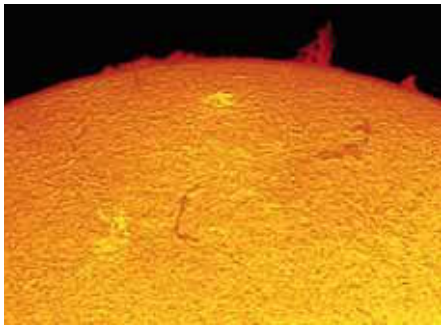
NGC 6188/6193

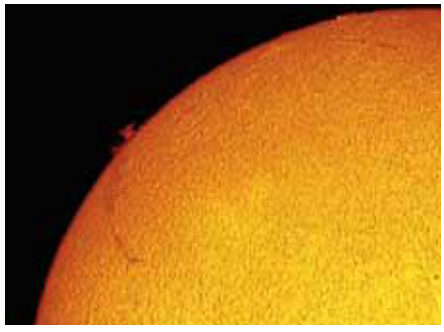
This terrific image shows a combination of objects: NGC 6188 is both an emission and a reflection nebula, and NGC 6193 is a star cluster. The red clouds of hydrogen form the emission nebula and emit red light because the gas atoms have been excited by the radiation of surrounding stars. Scattered and reflected starlight creates the faint blue color. Our clear daytime sky is blue for the same reason. A dark lane of dust stretches across the image, blocking some of the light that originates behind it. Adding to the visual appeal of this image, NGC 6193 is a magnitude-5.2 open cluster that can be seen in the same field of view as the nebula complex.

BRIGHT NEBULA NGC 6188/6193 IN ARA
(4-inch Pentax SDP 105 apochromatic refractor at f/6.7, Starlight Xpress SXV-H9 CCD camera, Hα/LRGB image with exposures of 30, 30, 26½, 13¼, and 16⅔ minutes, respectively)
/// GERALD RHEMANN AND MICHAEL JÄGER









Top left, SHARPLESS 2-132 IN CEPHEUS (6-inch Astro-Physics EDF refractor at f/7, 120-format Kodak PPF Pro 400 film, composite of three 60-minute exposures) /// GEORGE GREANEY

Top right, SOLAR PROMINENCE CLOSE-UP (6-inch Astro-Physics AP 155EDT apochromatic refractor at f/50, Olympus C-3040 digital camera, Solar Spectrum 0.2Å hydrogen-alpha filter, 1/20-second afocal, handheld exposures, taken April 17 through May 11, 2004) /// GREG PIEPOL

Bottom, NEBULA SURROUNDING MEROPE (12.5-inch homebuilt Newtonian at f/5, SBIG ST8i CCD camera, LRGB image with exposures of 60, 20, 20, and 40 minutes, respectively) /// CHRIS SCHUR

Send your photos to: ASTRONOMY reader gallery, P.O. Box 1612, Waukesha, WI 53187; e-mail to readergallery@astronomy.com.
Please include your full name, date and location of image, and complete photo data: telescope, camera, film, and exposure information.

Top, MARE CRISIUM (14-inch Celestron Schmidt-Cassegrain telescope at f/3.1, Nikon Coolpix 995 digital camera, 1/30-second exposure at ISO 100, taken October 12, 2003, at 23h35m UT from Athens, Greece) /// ANTHONY AYIOMAMITIS

Bottom left, PLANETARY NEBULA ABELL 36 (20-inch RC Optical Systems Ritchey-Chrétien telescope at f/8.4, SBIG ST-10 XME CCD camera, LRGB image with exposures of 105, 20, 20, and 20 minutes, respectively) /// MICHAEL T. O'CONNOR, TRISTAN DILAPO, GARY KIELICH, AND ADAM BLOCK

Bottom right, THE CALIFORNIA NEBULA (NGC 1499) (6-inch Astro-Physics EDF apochromatic refractor at f/7, Kodak 120 format PPF Pro 400 film, digital composite of two 60-minute exposures) /// GEORGE GREANEY

SPIRAL GALAXY NGC 3628 (16-inch RC Optical Systems Ritchey-Chrétien telescope at f/8; an SBIG ST-10XME CCD camera, LRGB image with exposures of 120, 20, 20, and 20 minutes, respectively) /// ADAM BLOCK

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